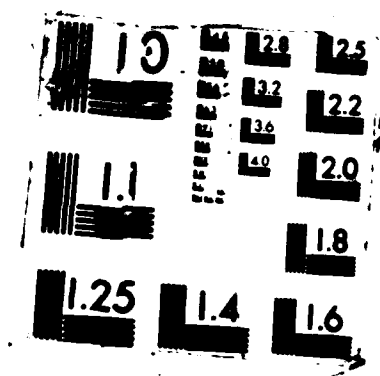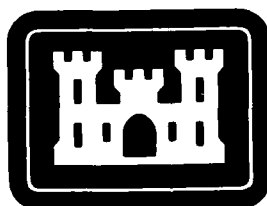⑫

Report No. 2

BIBLIOGRAPHY ON TIDAL HYDRAULICS

Supplement No. 10
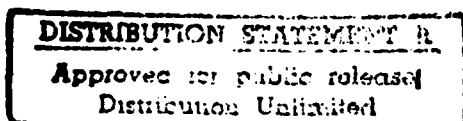
Supplementary Material
Compiled from June 1983 to June 1986

Tidal Flows in Rivers and Harbors

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Committee on Tidal Hydraulics
CORPS OF ENGINEERS, US ARMY

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PREFACE

Report No. 2, "Bibliography on Tidal Hydraulics," and Supplements 1-9 thereto were published by the Committee on Tidal Hydraulics in 1954, 1955, 1957, 1959, 1965, 1968, 1971, 1975, 1980, and 1985, respectively, in connection with certain of its objectives. This supplement consists of 497 references on the subject and includes both current and older references which have been accumulated. References not indicated by a dagger (†) are available for loan within the continental United States from the Library Branch, US Army Engineer Waterways Experiment Station (WES).

This supplement follows the same form as the original bibliography and consists of eight sections, each preceded by a brief statement of its scope. As a further convenience to the user, the references are arranged alphabetically under each subject matter heading (section), and all have been annotated. Although the majority of the references appear in more than one section, the complete entry appears only once--under the most applicable subject heading--with other listings giving only author, title, and key for its location.

Copies of this and other reports of the Committee may be obtained from the Committee on Tidal Hydraulics, care of US Army Engineer Waterways Experiment Station, ATTN: WESIM-TS, PO Box 631, Vicksburg, Mississippi 39180-0631.

This supplement was compiled by Katherine M. Kennedy, Special Projects Branch (SPB), Technical Information Division, Information Technology Laboratory (ITL), WES, under the general supervision of Mr. F. A. Herrmann, Jr., Chief, Hydraulics Laboratory, and Chairman, Committee on Tidal Hydraulics. Recognition is made of the following persons who provided assistance on this supplement: Marsha C. Gay, editor, Information Products Division, ITL, and Paul A. Taccarino, SPB, and F. E. Crevitt, Jr., Hydraulics Laboratory, who provided research services.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

CONTENTS

SECTION I. THEORETICAL CONSIDERATIONS

Basic principles of tidal hydraulics, including the mechanics and types of tides, height and time of tide, tide-producing forces, tidal currents, theories, cubature techniques, predictions, computations, estuarine circulation, and meteorological effects.

Abraham, G. 1980. "On Internally Generated Estuarine Turbulence," Proceedings, Second International Symposium on Stratified Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:344-353.

The processes producing turbulence and mixing must be examined carefully when dealing with stably stratified fluids. According to Turner (1973), a distinction must be made between "external" turbulence generated directly at a solid boundary, and "internal" turbulence arising in the interior. This observation is also applicable to estuarine mixing. At the one extreme, in a well-mixed estuary the turbulence is primarily boundary generated. At the other extreme, in a highly stratified estuary with an arrested salt wedge, the turbulence is primarily generated at the interface, i.e., in the interior of the stratified fluid. Nevertheless, the distinction between external and internal turbulence has not been made in the literature on estuarine mixing as yet (Fischer, 1976). The significance of this distinction is the subject of the present paper. The first part of the paper gives a theoretical criterion to determine under which circumstances the effect of internal turbulence on the production of turbulent energy exceeds the effect of external turbulence. The criterion is based on an approximate solution of the equation of motion in the longitudinal direction. The second part of the paper is an analysis of salinity intrusion field data collected in the Rotterdam Waterway and in the Chao Phya Estuary. This analysis confirms that above a certain level of stratification, internal effects are to be taken into account. The third part of the paper elaborates upon the implications of the aforementioned findings for the numerical two-dimensional simulation (with longitudinal and vertical space dimensions) of salinity intrusion in partly mixed estuaries. References (15 items).

Ali, A. "A Comparison Between Vertically Integrated and Multilevel Models of Tidal Dynamics in Channels." (See complete entry in Section VI.)

Amin, A., and Graff, J. "Some Notes on Simplifying the HSWC Method of Tidal Analysis." (See complete entry in Section VIII.)

Anwar, H. O. "Measurements on Entrainment Through a Front." (See complete entry in Section III.)

Anwar, H. O. 1983. "Turbulence Measurements in Stratified and Well-Mixed Estuarine Flows," Estuarine, Coastal and Shelf Science, 17(3):243-260.

From mean velocities measured in estuarine flows it has been found that the velocity distributions are log-linear in stratified flows and logarithmic in well-mixed flows. The results of salinity measurements reveal that the mean salinity profiles are geometrically similar and expressible as a power law. The buoyancy parameters, such as the Monin-Obukhov length scale and the gradient and the flux Richardson numbers, are independent of the flow state. The gradient and the flux Richardson numbers are almost equal, indicating the existence of a local equilibrium layer. The nondimensional parameter describing dissipation rates of turbulent kinetic energy is a constant of 0.2 and 0.3 for stratified and well-mixed flows, respectively. In well-mixed flow, the drag coefficient varies with time approaching a constant of about 3.2×10^{-3} when the flow is stratified. The shape of the turbulent energy spectra is generally flatter and broader in stratified as compared with those of well-mixed flows. References (30 items).

Awaji, T. 1982. "Water Mixing in a Tidal Current and the Effect of Turbulence on Tidal Exchange through a Strait," Journal of Physical Oceanography, 12(6):501-514.

By means of numerical calculations of the Lagrangian movement of water particles released in a turbulent tidal current during three cycles of the M_2 tide, the mechanism of tidal mixing of the inner and outer waters divided initially by a strait and the effect of turbulence on tidal exchange through the strait are studied. In the vicinity of the strait, combined with the large Stokes drift due to the spatially rapid changes of the amplitude and the phase lag of the tidal current, turbulence strongly affects the Lagrangian movement of particles. Some of initially adjacent particles moving in a turbulent tidal current have much larger drifts than the Stokes drifts (nonturbulent), and the others much smaller drifts than those. As a result, the adjacent particles released in a turbulent tidal current are widely scattered, and they are well mixed with water particles initially far apart from them, i.e., local mixing of water amplified to a great extent occurs compared with that due only to turbulence. By the interaction of a large degree of local mixing induced by the Stokes drift and turbulence in the vicinity of the strait and the dynamic process of tidal exchange through the strait, the inner and outer waters are also well mixed with each other over an extensive area around the strait. With regard to the effect of turbulence on tidal exchange between two basins connected by the strait, turbulence has a minor influence on water volume exchanged through the strait, but it has a major influence on the enlargement of sea areas

affected by tidal exchange. It is also shown that the dispersion coefficient evaluated from the variance of particle spread reaches 8×10^6 cm^2 s^{-1} in the vicinity of the strait. References (15 items).

Bartholdy, J. "Transport of Suspended Matter in a Bar-Built Danish Estuary." (See complete entry in Section VI.)

Basu, A. N. "Composite Mathematical Model of Saptamukhi River System Including Outfall Channels for Studying the Effect of Closure." (See complete entry in Section VI.)

Battisti, D. S., and Clarke, A. J. 1982. "A Simple Method for Estimating Barotropic Tidal Currents on Continental Margins with Specific Application to the M$_2$ Tide off the Atlantic and Pacific Coasts of the United States," Journal of Physical Oceanography, 12(1):8-16.

Theory is developed to describe barotropic tidal currents on "smooth" continental shelves, that is, continental shelves with longshore scales much greater than the shelf width. Two models are considered, one in which sea level does not vary significantly across the shelf and the other in which it does. Both models include longshore gradients and friction (parameterized linearly in velocity). The models were tested by calculating the M$_2$ tidal currents off the Atlantic and Pacific coasts of the United States and then comparing the calculated currents to those measured. Results show that theory and observation are in very good agreement as far offshore as 300 km. Along the Atlantic coast, on account of the wide continental shelf, current velocities are typically $O(0.10$-0.15 m s$^{-1})$ north of Cape Hatteras and $O(0.15$-0.28 m s$^{-1})$ off Savannah, Georgia. Currents rotate anticyclonically and are highly elliptical (ellipticity $E \approx -0.4$), with the semimajor axis oriented normal to the coast. Friction is significant in the South Atlantic Bight and acts to rotate the zero-friction current ellipses in a clockwise direction. Off the Pacific coast, where the continental shelf is narrow, M$_2$ tidal currents are relatively weak (0.02-0.08 m s^{-1}) and strongly oriented in the longshore direction ($E \approx 0.1$). The currents rotate counterclockwise with negligible friction influence. The good agreement between calculated barotropic M$_2$ currents and the observed currents off the southwest Pacific coast and all along the Atlantic coast of the United States suggests that the semidiurnal tides along these coasts are largely barotropic. References (9 items).

Battisti, D. S., and Clarke, A. J. 1982. "Estimation of Nearshore Tidal Currents on Nonsmooth Continental Shelves," Journal of Geophysical Research, 87(C10):7873-7878.

The theory of Battisti and Clarke to calculate analytically barotropic tidal currents across "smooth" continental margin topography is shown to be valid nearshore on "nonsmooth" continental shelves. The theory includes longshore gradients and friction and produces formulae easily evaluated with coastal sea level data. The tidal currents across three such shelves (West Florida, south of Long Island, and Vancouver Island) are calculated and compared with those observed. References (6 items).

Benqué, J. P., et al. 1982. "New Method for Tidal Current Computation," Journal, Waterway, Port, Coastal and Ocean Division, ASCE, 108(WW3):396-417.

The computation of two-dimensional tidal currents using the Alternating Direction Implicit Method (ADI) can be subject to numerical attenuation, parasitic oscillations, and poor reproduction of wave propagation when large time-steps are used. The new method described in the paper is designed to overcome these difficulties. It is based on a fractional step method in which momentum advection is calculated using the method of characteristics, horizontal momentum diffusion is calculated using an implicit finite difference scheme, and wave propagation is calculated using an iterative alternating direction implicit algorithm. The resulting method has been incorporated in the CYTHERE-ES1 modeling system, in which tidal flat flooding and drying as well as wind effects and Coriolis acceleration are taken into account. The basic principles of the method, as well as its application to four schematic test cases and two engineering studies, are described. References (14 items).

Berndt, D., et al. "Artificial Roughness in Physical Models of Estuaries for Storm Surge Investigations." (See complete entry in Section VI.)

Bottin, R. R., Jr., and Earickson, J. A. "Buhne Point, Humboldt Bay, California, Design for the Prevention of Shoreline Erosion; Hydraulic and Numerical Model Investigations." (See complete entry in Section VI.)

Bowman, M. J., et al. "Shelf Fronts and Tidal Stirring in Greater Cook Strait, New Zealand." (See complete entry in Section VI.)

Brazier, A., and Strachan, W. V. "Swansea Channel--A Study of Waterways Management." (See complete entry in Section V.)

Brocard, D. N., and Hsu, S.-K. "Combined Near- and Far-Field Water Quality Predictions in an Estuary." (See complete entry in Section VI.)

Brown, W. S. 1984. "A Comparison of Georges Bank, Gulf of Maine and New England Shelf Tidal Dynamics," Journal of Physical Oceanography, 14(1):145-167.

The semidiurnal tidal currents associated with the near-resonant response of the Gulf of Maine-Bay of Fundy system are amplified over the relatively shallow depths of Georges Bank, thus leading to enhanced energy dissipation, vertical mixing, and secondary flows on the Bank. Within the western Gulf of Maine, the tidal sea level amplitudes are larger but currents are less energetic than those observed on Georges Bank, while on the New England shelf the tidal response is the least energetic of the three regions. In this paper we explore some of the details of the tidal dynamics in these three very different tidal regimes by estimating terms in the volume-integrated momentum equations using observations of current and bottom pressure. The computations are performed for the M_2 semidiurnal tidal constituent, which is the dominant tide in all of the regions, and are presented in terms of an instantaneous "stress" balance. Results show that in the across-isobath direction on Georges Bank the M_2 inertial term is balanced principally by the sum of the Coriolis and pressure gradient terms plus a small residual term, while in the along-isobath direction the principal balance is between the inertial and Coriolis terms. Even in this region of relatively high currents the nonlinear terms are found to be small in both directions, thus justifying the use of monochromatic input data. The instantaneous dynamic balances and the clockwise rotary elliptical currents are quantitatively consistent with the signature of an across-isobath propagating, forced gravitational-gyroscopic progressive wave which is strongly influenced by bottom slope. In the western Gulf of Maine a sum of the inertial and Coriolis terms in both the along- and across-isobath directions is balanced by the relatively large pressure gradient terms--dynamic balances that are consistent with those of a rotary standing wave. The distribution of counterclockwise rotary elliptical currents suggests the presence of a reflected Kelvin wave in the western Gulf. On the less energetic New England shelf the across-isobath inertial term is balanced by a sum of the Coriolis and pressure gradient terms as found on Georges Bank. However, in the along-isobath direction, unlike Georges Bank, the same dynamical balance is found because of the importance of coastline irregularities in producing significant along-isobath tidal pressure gradients. The tidal response of the New England shelf combines the dynamical characteristics of those on Georges Bank and on the New Jersey shelf to the southwest and is less easily described in terms of the simple forced-wave models that are reasonably successful in the adjacent regions. The Georges Bank and Gulf of Maine observed tides are compared with the Greenberg fine-grid numerical results with generally good overall result. Some small systematic differences, which are found, may be due to the way friction is specified in the numerical model. Other results concerning the vertical structure and frictional character of Georges Bank tidal flow, which are presented here, suggest that the continued study of the way tidal energy dissipation is computed is warranted. References (27 items).

Buchak, E. M., and Edinger, J. E. "User Guide for CE-QUAL-ELV2: A Longitudinal-Vertical, Time-Varying Estuarine Water Quality Model." (See complete entry in Section VI.)

Butler, H. L. "Coastal Flood Simulation in Stretched Coordinates." (See complete entry in Section VI.)

Butman, B., et al. 1983. "An Upper Bound for the Tidally Rectified Current at One Location on the Southern Flank of Georges Bank," Journal of Physical Oceanography, 13(8):1452-1460.

Long-term current observations at 45 and 75 m at one location on the southern flank of Georges Bank in water 85 m deep were examined for evidence of tidal rectification. Loder has shown analytically that rectification of the strong semidiurnal tidal current can cause a mean along-bank flow, and thus may partially drive the observed clockwise circulation around Georges Bank. The amplitude of the tidally rectified along-bank flow is proportional to the squared amplitude of the cross-bank tidal current. A simple extension of Loder's model to include the weaker N_2 and S_2 tidal components suggests that fortnightly (354 h) and monthly (661 h) variations of the square of the cross-bank tidal current should cause a modulation of the subtidal along-bank flow. The predicted ratio (R) of the fortnightly and monthly modulation of the along-bank flow to the mean along-bank flow on the southern flank was a function of position and ranged from ~0.1-0.5. The amplitude of modulation of the along-bank flow at 360 and 648 h, estimated from the (weak) coherence between the observed

along-bank flow and the subtidal envelope
of a simulated surface tide, was less
than ~1.1 and 0.9 cm s^{-1}, respectively, at
45 m. The amplitude of the modulation
which can be attributed to tidal recti-
fication may be in error by the astronom-
ically forced Mm and MSf tidal currents,
which are undescribed in this region.
However, the magnitude of the mean along-
bank tidally rectified current determined
from the observed modulation and R pre-
dicted by the analytical model was
~2.0 cm s^{-1} at 45 m (36 percent of the
observed mean current in winter) and less
than 1.6 cm s^{-1} at 75 m (43 percent of the
observed mean current). Although R may
change in a more realistic model, this
analysis suggests that only part of the
seasonal-mean along-bank flow on the
southern flank of Georges Bank may be
caused by tidal rectification. References
(10 items).

Byrne, R. J., Gammisch, R. A., and Thomas,
G. R. 1980. "Tidal Prism-Inlet Area
Relations for Small Tidal Inlets," Pro-
ceedings, Seventeenth Coastal Engineering
Conference, March 23-28, 1980, Sydney,
Australia, ASCE, III:2517-2533.

Fourteen tidal inlets within the lower
Chesapeake Bay were studied to examine
whether significant differences existed in
their hydraulic behavior relative to the
larger oceanic inlets hitherto studied.
Measurements included simultaneous exter-
nal and internal tides, gaging of dis-
charge through a tidal cycle, measurements
of inlet geometry, and basin area. The re-
sults indicate that (a) smaller inlets (A_c
< 100 m^2) depart from the relationship
between inlet throat area and tidal prism
developed for oceanic inlets; (b) examina-
tion of inlet width versus depth indicates
the departure from ocean inlet geometry
occurs at A_c values between 100 and
500 m^2; (c) the maximum velocity in
smaller inlets is significantly less than
oceanic inlets (~0.35 versus 1.0 m/s);
(d) tidal phase lags and tidal range ratio
were generally equal. However, for con-
ditions of significant tide range reduc-
tion, the low-water phase lags more
closely approximated the tide range
ratio. References (20 items).

Carr, G. R. 1978. "Thames Flood Barrier,"
Papers, 7th International Harbour Con-
gress, K.V.I.V. (Royal Society of Flemish
Engineers), Antwerp, Belgium, 22-26 May
1978, I:3.10/1-3.10/16.

The Thames Flood Barrier under construc-
tion at Woolwich forms part of a compre-
hensive improvement of the River Thames
flood defenses to protect London and the
estuarial borders of Kent and Essex from
meteorologically induced tidal surges.
Due to sinking land levels and increasing

mean sea level and tidal range, extreme
high-water levels in London have increased
at a rate of about 0.8 m per century.
Environmental and economic reasons dicta-
ted the choice of a barrier rather than
continuing to raise the river walls in
London. The barrier will have ten hydrau-
lically operated steel gates supported on
concrete piers. Four 61-m-wide and two
31.5-m-wide openings will give unobstruc-
ted passage to shipping except when the
gates are closed to hold back a tidal
surge. The gates in these openings are of
a new type known as the rising sector
gate, the remaining four gates being of
the falling radial type. All barrier de-
sign aspects have been aimed at achieving
utmost reliability. The cost of the bar-
rier alone, estimated at March 1977, is
£207 million. Completion is expected in
1982. References (7 items).

Carton, J. A. 1983. "The Variation with
Frequency of the Long-Period Tides," Jour-
nal of Geophysical Research, 88(C12):7563-
7571.

The oceanic response to long-period tidal
forcing in closed basins approaches equi-
librium for periods much longer than a
month for moderate values of dissipation.
At a given frequency the response is clos-
est to equilibrium near the eastern wall
of the basin. Global calculations of the
Mf and Mm tides, made using a 2° × 2°
grid, are presented. Changes in the
length of day have also been computed for
these tides. References (19 items).

Chiang, W.-L., and Lee, J.-J. 1981. "Tide-
Induced Currents in Harbors of Arbitrary
Report No. USCSG-TR-01-81, Institute for
Marine and Coastal Studies, University of
Southern California, Los Angeles,
California.

The water quality in a harbor depends
strongly on its circulation patterns. As
a result, it is a primary importance to
find an efficient method to study and pre-
dict the harbor circulation. The goal of
the present study is to find an efficient
way of predicting tide-induced currents in
harbors of arbitrary shape and apply this
general technique to various configura-
tions (present and future) of Los Angeles-
Long Beach Harbor. In order to achieve
this goal, a numerical model for the har-
bor circulation problem is proposed. The
numerical method developed in this study
is capable of reproducing the gyre struc-
ture in the harbor. References
(118 items).

Christiansen, H., and Siefert, W. "Storm
Surge Prediction by Combined Wind and
Tide Data." (See complete entry in Sec-
tion VIII.)

Chu, W.-S., and Willis, R. "Mathematical Modeling of Humboldt Bay." (See complete entry in Section VI.)

Chu, W.-S., Yeh, W. W.-G., and Kristof, R. C. "Mathematical Modeling and Parameter Identification in a Two-Dimensional Estuary: Case Study of the Hydraulic Model of the San Francisco Bay and Delta." (See complete entry in Section VI.)

Coastal Sediments '77, Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE. (See complete entry in Section II.)

Colman, R. S. "The Modification of a Natural Drainage System and the Subsequent Effects on a Small Estuary and its Surrounding Beaches." (See complete entry in Section V.)

Committee on Tidal Hydraulics, Corps of Engineers, US Army. "Evaluation of Numerical Storm Surge Models." (See complete entry in Section VI.)

Cooper, C. K., and Pearce, B. R. "Development of a Simple Numerical Model to Calculate the 3-D Structure of Currents in Coastal Areas Using a Depth Varying Eddy Viscosity." (See complete entry in Section VI.)

Crout, R. L., and Murray, S. P. "Shelf and Coastal Boundary Layer Currents, Miskito Bank of Nicaragua." (See complete entry in Section VIII.)

Czerniak, M. T. "Engineering Concepts and Environmental Assessment for the Stabilization and Sand Bypassing of Moriches Inlet, New York." (See complete entry in Section II.)

Daifuku, P. R., and Beardsley, R. C. "The K_1 Tide on the Continental Shelf from Nova Scotia to Cape Hatteras." (See complete entry in Section VIII.)

Dandy, G. C., Mills, D. A., and Hinwood, J. B. 1980. "Water Movement Studies Required for Port Planning," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:3010-3026.

Some of the factors involved in the design of a program of measurement and analysis of current, temperature, and salinity data required for the environmental assessment of an estuarine port are considered in the context of a study carried out in the Port of Melbourne, Australia. The study was undertaken as part of the Port of Melbourne Environmental Study, 6 Webb Dock Marine Study, which was aimed at assessing the present regime and the effects on the marine and coastal environments resulting

from the construction of Berth 6, Webb Dock in Hobsons Bay. To this end, integrated investigations of water movement, water quality, coastal processes, and marine ecology were conducted. Although the results presented in this paper are specific to Hobsons Bay, the approach taken is of general applicability to the environmental assessment of proposed physical changes in complex estuaries and embayments. In such cases, the prediction of changed patterns of currents and density structure is a key element in assessing likely changes in other environmental factors such as water quality and the biota. In general, an environmental study of water movement in an estuary will involve some measurements of the existing conditions of current, temperature, and salinity, followed by appropriate analyses of these data to enable the likely changes to be predicted. References (5 items).

Davesne, M., and Graff, M. "Mathematical and Physical Models for Navigation in Approach Channels and Harbour Entrances." (See complete entry in Section V.)

Davies, A. M. "Role of 2D and 3D Models in JONSDAP '76." (See complete entry in Section VI.)

Devine, M. "Some Features of the Dynamic Structure of a Deep Estuary." (See complete entry in Section VI.)

Dronkers, J. 1978. "Longitudinal Dispersion in Shallow Well-Mixed Estuaries," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2761-2777.

In this paper theoretical expressions are obtained for dispersion processes of a particular type, which appear mainly as a consequence of the tidal motion and the geometry. The results may be applied to estuaries with strong tidal mixing (tidal prism of the same order of magnitude as the average volume of the estuary) and a small freshwater discharge. The cross sections in the estuary are divided in two parts: a deep part, representing the channel, in which the longitudinal motion takes place, and a shallow part without longitudinal motion, representing a tidal flat, which is filled and emptied by the tide. The interaction between these two parts generates longitudinal dispersion related with the following three phenomena: (a) mixing on the tidal flat caused by an irregular topography and by bottom friction, (b) exchange of water between the channel and the tidal flat caused by eddies or density currents, (c) the occurrence of a phase shift between the tidal elevation and the tidal velocity. An analytical expression for the contribution of these effects to the dispersion

coefficient is obtained by considering the
resulting transport of constituent through
a fixed plane. The application of the
model to general geometries is discussed,
providing an approximate expression for
the dispersion coefficient in natural
situations. This expression shows the
explicit dependency of the dispersion
coefficient on geometrical and tidal
parameters. References (2 items).

Durham, D. L. "Los Angeles Harbor and Long
  Beach Harbor: Analyses of Prototype Wave
  and Ship Motion Data." (See complete en-
  try in Section VIII.)

Duwe, K. C., and Hewer, R. C. "A Semi-
  implicit Tidal Model for Wadden Sea Areas
  (Ein semi-implizites Gezeitenmodell für
  Wattgebiete)." (See complete entry in
  Section VI.)

Dyer, K. R. "Mixing Caused by Lateral
  Internal Seiching Within a Partially
  Mixed Estuary." (See complete entry in
  Section III.)

Dyer, K. R. "The Mixing Processes in a Par-
  tially Mixed Estuary: Southampton Water."
  (See complete entry in Section VII.)

Ebbesmeyer, C. C., and Barnes, C. A. "Con-
  trol of a Fjord Basin's Dynamics by Tidal
  Mixing in Embracing Sill Zones." (See
  complete entry in Section VIII.)

Edinger, J. E., and Buchak, E. M. "Estu-
  arine Laterally Averaged Numerical Dynam-
  ics: The Development and Testing of Estu-
  arine Boundary Conditions in the LARM
  Code." (See complete entry in Sec-
  tion VI.)

Egan, J. T., and Jones, H. L. "Tidal Mea-
  surement, Analysis, and Prediction." (See
  complete entry in Section VII.)

Elahi, K. Z., and Sundermann, J. 1978.
  "The Wind-Driven Circulation in the North-
  ern Arabian Sea," _Proceedings, Sixteenth
  Coastal Engineering Conference, August 27-
  September 3, 1978, Hamburg, Germany_, ASCE,
  III:2708-2714.

  The circulation pattern in the northern
  Arabian Sea is presented for the well-
  defined wind fields, which are classified
  as the Southwest Monsoon and the Northeast
  Monsoon. To check the reproduction abil-
  ity of the model, first tidal waves are
  computed. The results show a good agree-
  ment with the known values given in
  literature. References (4 items).

Elliott, A. J. 1978. "Observations of the
  Meteorologically Induced Circulation in
  the Potomac Estuary," _Estuarine and
  Coastal Marine Science_, 6(3):285-299.

  For the 1-year period from July 1974

through July 1975, current measurements
were made at three depths in the Potomac
estuary. The records were first filtered
to remove the major tidal components and
then averaged within 24-hour blocks to
produce a sequence of estimates of the
residual flows during each calendar day.
The resulting low-pass currents revealed
fluctuations which had periods of 2-5
days, or longer, and whose amplitudes were
an order of magnitude larger than the
long-term means. Meteorological data were
also collected and it was found that the
nontidal currents were responding to two
distinct forcing mechanisms. One response
was due to the local wind and could ac-
count for 55 percent of the total variance
in the records; however there was a second
response, of almost equal importance,
which was caused by nonlocal effects prop-
agating into the estuary from the Chesa-
peake Bay. The nonlocal effects would
prevent the Potomac from being modeled as
an isolated system, and suggest that the
interaction with the Chesapeake Bay should
be included in a model of the wind-driven
response of the Potomac. The results from
the current meters at the three depths
were used to identify six distinct circu-
lation patterns. The circulation usually
associated with a partially mixed estuary
(surface outflow, inflow at depth) was the
most common, having a mean duration of
2.5 days and occurring for 43 percent of
the total time. The reverse of this cir-
culation (surface inflow, outflow at
depth) and storage (landward flow at all
depths) were the second most frequent pat-
terns, each occupying about 20 percent of
the total time. References (16 items).

Escoffier, F. F. 1977. "Hydraulics and
  Stability of Tidal Inlets," GITI Re-
  port 13, US Army Engineer Waterways
  Experiment Station, Vicksburg, Miss.

  This report presents a summary of several
  of the important basic developments per-
  taining to analysis of the hydraulics and
  related stability of tidal inlets. The
  original inlet stability concept proposed
  by Escoffier is extended in light of re-
  cent work. The report also contains brief
  discussions on tidal inlet characteristics
  and functional design requirements as well
  as case studies of selected inlets on the
  United States coasts. References
  (44 items).

Essen, H.-H., Gurgel, K.-W., and Schirmer,
  F. 1983. "Tidal and Wind-Driven Parts of
  Surface Currents, as Measured by Radar,"
  Deutsche Hydrographische Zeitschrift,
  36(3):81-96.

  In December 1982, surface current measure-
  ments by means of an HF radar station were
  carried out from the Federal German island
  of Sylt in the North Sea. Two carrier
  frequencies (30.1 MHz and 29.85 MHz) were

tested with respect to their applicability. Hourly sampled 70-hours time series of (1-dimensional) radial currents at different distances and directions from the radar are analyzed with the objective of determining the tidal and wind-driven parts. Assuming a homogenous current field, semidiurnal tidal ellipses are synthesized and compared with currents, as documented in the "Atlas der Gezeitenströme in der Deutschen Bucht" (Deutsches Hydrographisches Institut [1983]). References (13 items)

Evans, J. J., and Pugh, D. T. 1982. "Analysing Clipped Sea-Level Records for Harmonic Tidal Constituents," The International Hydrographic Review, 59(2):115-122.

Coastal sea-level measurements must sometimes be made at sites where the gage dries out at low levels. By progressively removing the lower part of a tidal record and analysing the remainder with the conventional least-squares criteria, stable values of the principal constants have been obtained until only half of the original range remained. This stability has implications for the definitions of tidal constants and of mean sea level in regions of very shallow water and drying banks. References (6 items).

Everts, C. H. "A Method to Predict the Stable Geometry of a Channel Connecting an Enclosed Harbor and Navigable Waters." (See complete entry in Section II.)

Falconer, R. A. "Mathematical Model Study of Mass Transport in Harbours." (See complete entry in Section VI.)

Falconer, R. A. "Modelling of Planform Influence on Circulation in Harbours." (See complete entry in Section VI.)

Fandry, C. B. "Development of a Numerical Model of Tidal and Wind-Driven Circulation in Bass Strait." (See complete entry in Section VI.)

Fandry, C. B. "Model for the Three-Dimensional Structure of Wind-Driven and Tidal Circulation in Bass Strait." (See complete entry in Section VI.)

Ferentinos, G., and Collins, M. "Effects of Shoreline Irregularities on a Rectilinear Tidal Current and Their Significance in Sedimentation Processes." (See complete entry in Section II.)

Fiadeiro, P. M. 1978. "Study of Water Quality in the Tagus Estuary" ("Etudes sur la Qualite de l'Eau dans l'Estuaire du Tage"), La Houille Blanche, 33(6):431-434 (In French).

The Tagus Estuary plays a particularly important part in the country's economy.

Attempts have been made to determine the flow characteristics in the estuary, analyse trends, establish correlations and determine dispersion coefficients. The tidal prism is of considerable magnitude ($7\times10^{**}8$ m**3) and the flow is characterized essentially by two-layer flow, with both diffusive and advective processes assisting the salt flux upriver. References (10 items).

Filloux, J. H., and Snyder, R. L. "A Study of Tides, Setup and Bottom Friction in a Shallow Semi-Enclosed Basin; Part I: Field Experiment and Harmonic Analysis." (See complete entry in Section VIII.)

Fischer, H. B. 1977. "The Effect of Estuarine Circulation on Pollution Dispersal," Estuarine Pollution Control and Assessment, Proceedings, Conference, Washington, D.C., Environmental Protection Agency, March 1977, II:477-485.

This paper gives a brief review of different types of circulation in estuaries, how they act to disperse pollutants, and to what extent the dispersion process can be modeled by existing analytical, numerical, and hydraulic models. References (23 items).

Fischer, H. B., et al. 1979. Mixing in Inland and Coastal Waters, Academic Press, Inc., New York.

Chapter 1 discusses the relevance of this book to overall environmental management and explains certain basic concepts which apply throughout, such as dimensional reasoning. Chapter 2 presents the classical theory of diffusion in the context of molecular diffusion, primarily as an introduction to the equations and concepts used in later chapters. Chapter 3 introduces the necessary statistical concepts and concludes with a useful summary of the limitations of the Fickian equation in turbulent mixing. Chapter 4 describes shear flow dispersion--that phenomenon that describes the stretching and mixing of pollutant clouds caused by the combined action of shear and lateral mixing--and completes the presentation of background material necessary to the study of mixing in the environment. Chapter 5 treats transverse mixing and longitudinal dispersion in rivers. Chapter 6 on mixing in reservoirs discusses density structure and its effect on internal motions and mixing processes. Estuarine mixing, discussed in Chapter 7, includes wind-driven circulation, tidal shear, residual circulation, dead zones and gravitational circulation due to salinity gradients. The section on one-dimensional analysis of pollutant dispersion is primarily concerned with models employing the concept of averaging over a tidal period. Chapter 8 contains a rather abbreviated description of numerical.

techniques and Eulerian and Lagrangian approaches. The San Francisco Bay model is used as a case study for discussion of the role of distorted physical models. Chapter 9 treats buoyant jets and plumes, strong man-induced flow patterns used to achieve rapid initial dilutions for water quality control. Chapter 10 gives a design-oriented discussion of outfall diffusers and includes sections on the internal hydraulics of outfalls and the techniques of hydraulic modeling of outfall flows with density differences. References (309 items).

Fischer, K. "Numerical Tidal-Salinity Models of the Ems Estuary." (See complete entry in Section VI.)

FitzGerald, D. M., Fico, C., and Hayes, M. O. "Effects of the Charleston Harbor, S.C., Jetty Construction on Local Accretion and Erosion." (See complete entry in Section II.)

Fleming, J. H., McMillan, P. H., and Williams, B. P. "The River Hull Tidal Surge Barrier." (See complete entry in Section V.)

Foster, D. N., McGrath, B. L., and Bremner, W. "Rosslyn Bay Breakwater, Queensland, Australia." (See complete entry in Section VI.)

Franco, A. d. S. 1980. "On the Shallow-Water Harmonic Tidal Constituents," _International Hydrographic Review_, 57(2): 139-150.

This is an investigation of the physical law governing the interaction of the astronomical tidal constituents which generates the shallow-water tidal constituents, for the simple case of a narrow channel. The solution for both progressive and standing waves, up to the fifth order, is presented. The fluid is supposed nonviscous, and the flow frictionless. References (12 items).

Freeland, H. J. 1979. "Tidal Analysis and the Energy Budget of a Deep Stratified Inlet," _Symposium on Long Waves in the Ocean_, June 6-8, 1978, Manuscript Report Series No. 53, Marine Sciences Directorate, Department of Fisheries and the Environment, Ottawa, Ontario, 49-51.

Knight Inlet is a fjord on the mainland of British Columbia, Canada. The tides in the inlet are mixed type, predominantly semidiurnal. The inlet is generally deep, but has a sill, 75 km from the head of the inlet, where depth drops to about 60 m. The sill is in the middle of a long straight section of the inlet, which is connected to the head by a sinuous stretch, about 50 km in length. References (2 items).

Gardner, G. B., and Smith, J. D. 1980. "Observations of Time-Dependent, Stratified Shear Flow in a Small Salt-Wedge Estuary," _Proceedings, Second International Symposium on Stratified Flows_, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:944-951.

The Duwamish Waterway is a small, salt-wedge type estuary in Seattle, Washington. In addition to the large stratification typical of salt-wedge estuaries, the Duwamish is influenced by a large tidal amplitude which results in a highly time-dependent flow. Two types of internal hydraulic phenomena have been observed: an internal wave field which exists over an extended region, and a large-amplitude internal lee wave caused by flow between support structures for a bridge. Both grow to unstable amplitudes during the ebb, and contribute to vertical mixing. The model of Lee and Su (1977) is used to investigate the nature of these phenomena, and the results are compared with echo-sounder images of the pycnocline. References (4 items).

Garvine, R. W. "River Plumes and Estuary Fronts." (See complete entry in Section III.)

Gatto, L. W. 1978. "Estuarine Processes and Intertidal Habitats in Grays Harbor, Washington; A Demonstration of Remote Sensing Techniques," CRREL Report 78-18, US Army Cold Regions Research and Engineering Laboratory, Hanover, N. H.

The utility of remote sensing techniques as an operational tool in the acquisition of data required by the USACE in the Grays Harbor, Wash., project was demonstrated. Aerial imagery was used to map surface circulation and suspended sediment patterns near the hopper dredge pump site at the harbor entrance and near pulpmill outfalls in Aberdeen, Wash. Using primary aerial color infrared (CIR) photography and ground surveys, the areal distribution and extent of nine wetland vegetation types, dune vegetation, and three types of eelgrass were also mapped. Thermal imagery was more useful than CIR photographs for mapping circulation; CIR photographs were more useful than thermal imagery for mapping intertidal habitats. Current velocities estimated by remote sensing techniques were comparable at some locations to current velocities measured by in situ current meters. References (49 items).

George, K. J. 1982. "Application of the Species Concordance Method to the Tidal Currents in the Loire" ("Application de La Méthode des Concordances Par Espèce À La Marée Dans La Loire"), _Annales_

Hydrographiques, 10(757):51-63 (In French).

The species concordance method, perfected by Simon for the Gironde, has been extended to the tide in the Loire estuary. It has been improved in a significant way by the introduction of a new formula. Moreover it lends itself to necessary modifications so as to take into account the river level variations which are important in the Loire. References (3 items).

George, K. J., and Simon, B. 1984. "The Species Concordance Method of Tide Prediction in Estuaries," *The International Hydrographic Review*, 61(1):121-146.

The harmonic method of tide prediction is developed to its fullest extent, so that it can deal with tide curves which are so distorted that they have gradient discontinuities. It is better, however, to use a new two-step method known as the method of species concordance. This method is applied to the Gironde, and then to the Loire, where the variation in freshwater level is important. References (6 items).

Gerrard, R. T., Long, J. J., and Shah, H. R. "Barking Creek Tidal Barrier." (See complete entry in Section V.)

Gibbs, R. J. 1982. "Currents on the Shelf of North-eastern South America," *Estuarine, Coastal and Shelf Science*, 14(3): 283-299.

From the continental shelf region extending 400 km north of the mouth of the Amazon River, current-meter data and data on salinity, temperature, and suspended material were analyzed to study mean and tidal currents. Based on a grid-point system, the mean circulation patterns along the shelf are shown and the temporal variations in the tidal currents are depicted for the region at 2-hr intervals. Maximum and minimum current speeds were studied for information on the spatial structure of the flow and on the along-shelf and across-shelf components. References (14 items).

Gibbs, R. J. "Suspended Sediment Transport and the Turbidity Maximum." (See complete entry in Section II.)

Gibson, R. A., and Wilson, E. M. "Tidal Energy Integration Using Pumped Storage." (See complete entry in Section V.)

Glen, N. C. "The Tidal Survey of the British Isles." (See complete entry in Section VII.)

Godin, G. 1984. "The Tide in Rivers," *The International Hydrographic Review*, 61(2):159-170.

The tide in a river consists of waves

which propagate into it from the ocean and which are distorted by friction and by the discharge of fresh water. Observations show that, as it progresses upstream, the time interval between low water (LW) and high water (HW) shortens so that the duration of ebb increases steadily. In extreme cases the level rises abruptly in some portions of the river and a shock wave develops, the bore. The tide in a river has other characteristics which are not as well known: (a) The semidiurnal component of the tide progresses upstream more rapidly than the diurnal component and it is more affected by friction. (b) HW progresses more rapidly than LW. (c) LW progresses faster in the estuary, while it is slowed down in the upstream region, during neap tides. The reverse holds during spring tides. (d) An increased discharge of fresh water diminishes the range of the tide. It increases the velocity of LW in the upstream portion of the river while it may enhance the range in some parts of the estuary. (e) Slow semimonthly and monthly oscillations in the level are induced in the upstream region by the succession of neap and spring tides downstream. (f) The tide in the upstream region cannot be reproduced by a one-dimensional model. References (3 items).

Gopalakrishnan, T. C., and Machemehl, J. L. 1980. "Boundary Conditions for Analysis of Flow in Tidal Inlets," *Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia*, ASCE, III:2595-2606.

One-dimensional gradually varied flow analysis of flood routing and inlet flows (Mahmood and Yevjevich, 1975; Amein, 1975; and Hinwood and Wallis, 1975) has been a subject of study in the last few decades; and many mathematical models have been developed based on those studies. A common feature in all these models is that the boundary conditions at the ends of the channel reaches are supplied from measured values of stage, discharge, or velocity. These boundary conditions form an integral part of the mathematical models. In the case of implicit schemes, without the supply of these boundary conditions there will be more unknowns than equations. Even though in the explicit schemes they are not required in order to supply sufficient equations, it is obvious that the flow will not be properly simulated without imposing proper end conditions of flow. Normally two end conditions will be required, the upstream and downstream conditions, even though in a network of channels there will be more than two end conditions. Of these two, the upstream condition is usually the forcing function and the downstream one is the result of the flow due to the forcing function. The

downstream condition depends on what
happens to the flow outside the system.
In other words, it depends on the shallow-
water wave reflections from the continua-
tion of the channel beyond the downstream
end of the system considered. These re-
flections are characterized by the expan-
sion or contraction of the channel, the
rate of change of the side slopes, and
other channel characteristics. As men-
tioned earlier, the downstream end condi-
tion is supplied from measured values of
flow parameters so that the channel fea-
tures (outside the system) mentioned above
are automatically simulated. However, if
it is required to know the response for
any given forcing function, the corre-
sponding measured downstream values may
not be available. This means that the
downstream boundary condition cannot be
imposed in the usual way. This paper de-
scribes a method by which the downstream
boundary condition can be imposed in the
absence of measured downstream response
to a given forcing function. However, the
method presupposes that measured values
for at least one forcing function are
known as part of the features of the chan-
nel or channel system. References
(4 items).

Gopalakrishnan, T. C., and Machemehl, J. L.
"Verification of a Numerical Flow Model
for Carolina Beach Inlet, North Carolina."
(See complete entry in Section VI.)

Gordon, D. C., and Longhurst, A. R. "The
Environmental Aspects of a Tidal Power
Project in the Upper Reaches of the Bay
of Fundy." (See complete entry in Sec-
tion V.)

Gourlay, M. R., and Hacker, J. L. "The
Interaction Between Fluvial and Tidal
Processes in the Pioneer River Estuary."
(See complete entry in Section II.)

Graham, D. S., Hill, J. M., and Christensen,
B. A. "Verification of Estuarine Model
for Apalachicola Bay, Florida." (See com-
plete entry in Section VI.)

Greer, M. N., and Madsen, O. S. "Longshore
Sediment Transport Data: A Review." (See
complete entry in Section II.)

Hale, J. "Emergency Erosion Protection
and Contingency Planning for Los Angeles
County." (See complete entry in Sec-
tion II.)

Hales, L. Z. "Erosion Control of Scour
During Construction; Report 8, Summary
Report." (See complete entry in Sec-
tion V.)

Hall, R. W., Jr. "Evaluation of Marsh
Estuarine Water Quality and Ecological
Models: An Interim Guide." (See complete
entry in Section VI.)

Hamilton, A. D. 1980. "Nontidal Cir-
culation and Mixing Processes in the Lower
Potomac Estuary," Estuaries, 3(1):11-19.

The vertical structure of nontidal longi-
tudinal currents and salinity in a reach
of the lower Potomac River estuary, Chesa-
peake Bay, was studied. Values for verti-
cal eddy viscosity and eddy diffusivity
scale with water depth H , tidal current
amplitude U , and bulk Richardson number
were determined by conventional empirical
formulas. The constant which relates the
vertical eddy coefficients under condi-
tions of neutral stability to UH was an
order of magnitude less than that expected
for tidal conditions. The degree of en-
hancement of longitudinal dispersion by
the shear effect associated with the non-
tidal currents is a strong function of
bulk Richardson number. References
(10 items).

Hamrick, J. M. "Baroclinic Circulation and
Dispersion in Estuaries." (See complete
entry in Section III.)

Harleman, D. R. F. "Diffusion and Disper-
sion Processes." (See complete entry in
Section VI.)

Harten, H. "Improvements on Tidal Estuaries
and the Effects on Tidal Current." (See
complete entry in Section V.)

Hartnoll, R. G., and Hawkins, S. J. "The
Emersion Curve in Semidiurnal Tidal
Regimes." (See complete entry in Section
VIII.)

Haury, L. R., et al. "Tidally Generated
High-Frequency Internal Wave Packets
and their Effects on Plankton in Massachu-
setts Bay." (See complete entry in Sec-
tion VIII.)

Häuser, J., Eppel, D., and Tanzer, F.
"Analysis of Thermal Impact in Tidal
Rivers and Estuaries." (See complete
entry in Section VI.)

Hawley, N. 1982. "Intertidal Sedimentary
Structures on Macrotidal Beaches," Journal
of Sedimentology Petrology, 52(3):785-795.

A one-month survey of three macrotidal
beaches located in south Wales has shown
that the distribution of bed forms in the
intertidal zone is controlled primarily by
wave climate and tidal range. The areas
near the high- and low-water marks reflect
the predominance of swash-zone action,
whereas the middle part of the beach is
more likely to contain bed forms formed in
either the breaking or shoaling wave
zones. Since none of the structures were
formed by current action, changes in tidal
range affected only the width of the
areas, not the type of bed form deposited.
The bed forms observed varied little in

with changes in wave height; on high wave-energy beaches, the model of Clifton et al. is valid, whereas on lower energy beaches it must be modified. The rapid response of the beaches to changes in wave climate makes it unlikely that bed forms will be preserved except possibly during extremely severe storms, when the lowermost part of the bed forms might be preserved as part of a vertical sequence produced by migrating facies. References (23 items).

Hayes, M. O., Kana, T. W., and Barwis, J. H. "Soft Designs for Coastal Protection at Seabrook Island, S. C." (See complete entry in Section VIII.)

Heath, R. A. "Generation of the M_4 Tide in Cook Strait, New Zealand." (See complete entry in Section VI.)

Heathershaw, A. D., Carr, A. P., and Blackley, M. W. L. "Swansea Bay (SKER) Project, Topic Report 8; Coastal Erosion and Nearshore Sedimentation Processes." (See complete entry in Section II.)

Heathershaw, A. D., and Hammond, F. D. C. 1979. "Swansea Bay (SKER) Project, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations and Their Response to Meteorological Conditions," Report No. 92, Institute of Oceanographic Sciences, Crossway, U.K. (Unpublished Manuscript).

This report describes the tidal and residual current circulation patterns in Swansea Bay, particularly how they effect sediment transport toward or away from the foreshore. Consideration is given to wind-driven currents, surge currents, and density currents. References (69 items).

Heathershaw, A. D., and Hammond, F. D. C. "Swansea Bay (SKER) Project, Topic Report 6; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data." (See complete entry in Section II.)

Heathershaw, A. D., and Lees, B. J. 1980. "Sizewell-Dunwich Banks Field Study, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations," Report No. 104, Institute of Oceanographic Sciences, Crossway, U.K. (Unpublished Manuscript).

Recording current meter data, tidal elevations, and meteorological data have been used to examine the tidal and residual circulations in the area and their response to meteorological forcing. Current meter data have confirmed that the tidal currents are essentially rectilinear with ellipticities of the order of 5 percent and less and with tidal stream maxima of

the order of 100 cm s^{-1}. The residual flow pattern in the area is complex although there is evidence of an anticlockwise eddy in the mean circulation, which is situated over the Sizewell Bank and possibly extends to cover the Dunwich Bank. Current measurements from a long-term current meter mooring have confirmed that the residual circulation is likely to be influenced by meteorological forcing. In particular, the alongshore components of the residual flow and wind stress are well correlated during storm periods. Analysis of current meter and tidal elevation data has shown that the tides in this area may be considered as a mixture of standing wave and progressive wave oscillations, consistent with the proximity of the study area to an amphidrome. For both the M_2 and S_2 tides, the standing wave component is dominant. References (26 items).

Hickel, W. "The Influence of Elbe River Water on the Wadden Sea of Sylt (German Bight, North Sea)." (See complete entry in Section III.)

Higuchi, H., Yasuda, H., and Hayakawa, N. "Experimental Study on Scale Effect of Tidal Model." (See complete entry in Section VI.)

Hinwood, J. B. 1978. "Large Scale Turbulence in Tidal Currents," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2598-2601.

Aerial photographs of tidal inlets sometimes show an orderly pattern of large eddies or cells aligned in long rows along the mean streamlines. A highly ordered "cellular" structure of turbulence has been observed in strong tidal currents. The cells have only been observed where the velocity is high and have not been observed during strong winds. The cell dimensions are in the order of the water depth and velocities about one-tenth those of the main current. The observation of cells is described, but their complete structure and origin are not yet known; however, it has been established that density variations are not a factor. References (3 items).

Holloway, P. E. "Internal Tides on the Australian North-West Shelf: A Preliminary Investigation." (See complete entry in Section VIII.)

Holloway, P. E. "Tides on the Australian North-west Shelf." (See complete entry in Section VIII.)

Holz, K.-P., and Januszewski, U. "Automatic Calibration of Numerical Tidal Models." (See complete entry in Section VI.)

Hopkins, T. S., Salusti, E., and Settimi, D.
"Tidal Forcing of the Water Mass Interface
in the Strait of Messina." (See complete
entry in Section VIII.)

Howarth, M. J. "Intercomparison of Current
Meters in Fast Tidal Currents." (See com-
plete entry in Section VII.)

Howell, G. "Florida Coastal Data Network."
(See complete entry in Section VII.)

Hsueh, S. F., and Ahlert, R. C. "Mixing in
Shallow Coastal Sea: Case Study." (See
complete entry in Section VI.)

Hubbard, D. K., Oertel, G., and Nummedal, D.
1979. "The Role of Waves and Tidal Cur-
rents in the Development of Tidal-Inlet
Sedimentary Structures and Sand Body Geo-
metry: Examples from North Carolina,
South Carolina, and Georgia," Journal of
Sedimentary Petrology, 49(4):1073-1092.

Morphologic variability in tidal inlets
along the southeastern coast of the United
States has been considered with respect
to the distribution of large-scale sand
bodies, intertidal and subtidal bed forms,
and internal sedimentary structures. Data
indicate that the morphologic variability
in these inlets can be largely explained
as a response to waves and tides. Other
factors (tidal prism, inlet cross-
sectional area and shape, the nature of
the back-barrier bay, the degree of flood
or ebb dominance, freshwater input, rela-
tive changes in sea level and sediment
supply) exhibit lesser controls and their
effects are less easily quantified. Three
types of inlets are identified: tide-
dominated, wave-dominated, and transi-
tional. (a) Tide-dominated inlets are
characterized by a deep, ebb-dominant main
channel flanked by long, linear channel-
margin bars. Flood-tidal deltas are
poorly developed or nonexistent. Sand
bodies landward of the inlet throat are
confined to tidal point bars further land-
ward in the marsh creek system. (b) Wave-
dominated inlets are characterized by
large, lobate flood-tidal deltas building
into wide, open lagoons. The ebb-tidal
delta is small and extends only a short
distance from the beach. Tidal channels
are generally shallow (less than 6 m) and
often bifurcate landward and seaward of
the throat. (c) In transitional inlets,
major sand bodies are typically concen-
trated in the inlet throat. These inlets
vary widely in morphology and sand body
geometry. Logically, this variability
should be expressed in the rock record.
In a vertical section through a tide-
dominated inlet channel, a coarse base,
overlain by bidirectional trough cross
stratification from the deep channel and
ebb-oriented, planar and trough cross
stratification from the shallower channel

should be expected. Swash-generated,
horizontal plane laminations or slightly
inclined accretion beds formed along the
channel margins are less likely to be pre-
served. In contrast, a wave-dominated
inlet sequence would contain primarily
landward-oriented, planar and cross strat-
ification from the shallower channel bot-
tom, overlain by dominantly horizontal or
slightly inclined plane laminations from
the shallow channel sides. Transitional
inlets would produce a variety of se-
quences, the exact nature of which would
reflect the relative importance of waves
and tides. References (57 items).

Hunkins, K. "Salt Dispersion in the Hudson
Estuary." (See complete entry in Sec-
tion III.)

Huntley, D. A., and Nummedal, D. "Velocity
and Stress Measurements in a Tidal
Inlet." (See complete entry in Sec-
tion VII.)

Huthnance, J. M. "On the Formation of Sand
Banks of Finite Extent." (See complete
entry in Section VI.)

Huzzey, L. M. 1982. "The Dynamics of a
Bathymetrically Arrested Estuarine Front,"
Estuarine, Coastal and Shelf Science,
15(5):537-552.

The mixing and circulation associated with
a bathymetrically arrested estuarine front
were studied using hydrographic and cur-
rent data. A quasi-steady front, exhibit-
ing strongly convergent surface flows, is
formed along the steeply sloping inner
margins of the flood tide delta during
each semidiurnal tide cycle. This front
separates the brackish ambient water
within a deep estuarine basin from the
incoming oceanic tidal water. The posi-
tion of the front is dependent on the
local water depth and the difference in
density between the two water masses.
Beneath the surface there is an inclined
frontal interface where static stability
is very low and vertical mixing intense.
A vertically integrated horizontal momen-
tum equation was derived for flow in the
upper layer and an estimate made as to the
value of the associated entrainment coef-
ficient. References (24 items).

Imasato, N. "What is Tide-Induced Residual
Current?" (See complete entry in
Section VI.)

Indlekofer, H. "On Numerical Stability of
One-Dimensional Seciment Transport Models
for Unsteady and Tidal Flows." (See
complete entry in Section VI.)

Ingram, R. G. 1980. "Generation and Decay
of an Estuarine Front," Proceedings, Sec-
ond International Symposium on Stratified

Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980,Torkild Carstens and Thomas McClimans, ed., 1:548-550.

This is a brief article which describes the T-S and velocity characteristics of a convergent surface front along the northern boundary of Ile Rouge Bank in the St. Lawrence estuary. References (3 items).

Jiang, J. X., and Falconer, R. A. "On the Tidal Exchange Characteristics of Model Rectangular Harbours." (See complete entry in Section VI.)

Jones, I. S. F., and Padman, L. 1983. "Semidiurnal Internal Tides in Eastern Bass Strait," _Australian Journal of Marine and Freshwater Research_, 34(1):159-171.

Variations in the vertical thermal structure near the shelf break in eastern Bass Strait have been observed for a 1-year period during 1980-1981. For the periods when the water column was stratified, energetic oscillations of the thermocline were frequently observed, these being well correlated with the surface tide. A peak occurred at the semidiurnal frequency in approximately half of the spectra, each constructed from 4 days of thermistor records. The amplitude of this internal tide was up to 40 m from crest to trough in February 1981. The internal tide lagged the surface tide by 0-6 hr in the five records analyzed for phase. This, together with the consistency of phase in longer records, supports the proposal that these internal motions were due to forcing not far from the site of observation. It is suggested that topographic forcing can be scaled on the parameter $h^{-2} \partial h/\partial x$, where h is water depth and x is measured perpendicular to the isobaths, and a map of this parameter shows a line of strong generation near the 100-m isobath, about 10 km from the measurement site. References (16 items).

Joshi, P. B. 1982. "Hydromechanics of Tidal Jets," _Journal, Waterway, Port, Coastal and Ocean Division_, ASCE, 108(WW3):239-253.

A unified theoretical investigation of the fully developed region of a tidal jet is presented. The jet is treated as a vertically averaged flow and the effects of lateral mixing, bottom friction, and variable bathymetry are included. It is shown, without assuming any specific form of the similarity function, that the cross-stream length scale and the center-line velocity of the jet must satisfy certain differential equations in order for the jet to be self-similar. Solutions of these equations are obtained for some simple forms of bottom topography. For a flat, frictional bottom, the jet exhibits

exponential growth and decay of the center-line velocity which is in agreement with earlier investigations. An exact analytical solution for the similarity function is obtained upon introduction of Prandtl's eddy viscosity hypothesis. The theory contains two free constants which must be determined in future experimental investigations. References (13 items).

Joshi, P. B., and Taylor, R. B. "Circulation Induced by Tidal Jets." (See complete entry in Section VI.)

†Kabbaj, A., and LeProvost, C. 1980. "Nonlinear Tidal Waves in Channels: A Perturbation Method Adapted to the Importance of Quadratic Bottom Friction," _Tellus_, 32(2):143-163.

Bottom friction plays an important role in the propagation and damping of long waves in shallow water. A perturbation method, well adapted to the importance of this bottom stress, is presented and applied for channels with constant mean depth and mean cross-section area. The main idea results from a development of quadratic bottom friction in a Fourier series up to the third order of approximation. A quasi-linearization of the damping effect of bottom stress is deduced from this expansion, which allows one to introduce the second-order damping effects of friction into the first-order system defining the fundamental component of the spectrum, and the main part of the third-order damping terms into the computation of the second-order harmonic components. From this expansion, the generating role of the harmonic played by friction is also identified and taken into account in the second-order approximation. Analytical and ana-lyticonumerical solutions are presented and compared to numerical solutions of the full nonlinear equations obtained by the Lax-Wendroff (L-W) finite difference integration technique. These comparisons show that the analytical solutions limited to the second-order approximation fit very well with the L-W solutions.

Karunartne, D. A. 1980. "An Improved Method for Smoothing and Interpolating Sea Level Data," _The International Hydrographic Review_, 57(1):135-148.

A method for smoothing and interpolating observed hourly digital tidal elevations is presented. The method which is based on fitting a small number of harmonic tidal components to the data series has proved to be superior to standard smoothing procedures and can be applied to data from different tidal regimes. The method is relatively simple, economical, and can be executed on standard digital computers with limited storage capacity. References (5 items).

Kashiwamura, M., and Yoshida, S. 1978. "Outflow Dynamics at a River Mouth," _Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany_, ASCE, III:2925-2944.

This paper consists of two main parts, one of which is on the transient behavior of the fresh water, when it passes through a river mouth, and the other is on the mechanism of mixing of two layers inside and outside the river mouth. In the former, the freshwater flow is concluded to be dynamically identical with the transonic flow in aerodynamics. In the latter, three types of mixing are described. One is that of the Kelvin-Helmholtz instability, found outside the mouth. Another is a new type due to the interference of the interfacial waves and the roughness at the interface. This type is expected to occur inside the mouth. The last one is that induced by the tidal current. References (11 items).

Kato, M. 1979. "Observation of Crustal Movements by Newly-Designed Horizontal Pendulum and Water-Tube Tiltmeters with Electromagnetic Transducers (2)--Variations in the Amplitude and Phase of Tidal Tilts Observed with a Water-Tube Tiltmeter at Kamitakara," _Bulletin of the Disaster Prevention Research Institute_, Kyoto University, Kyoto, Japan, Part 2, 29(263): 83-87.

Using the data collected over nearly one year obtained with a water-tube tiltmeter installed at the Kamitakara Station (36°17' N, 137°20' E, H = 800 m) in the northwestern Chubu region, Japan, temporal variations in the amplitude and phase of the M_2 and O_1 constituents have been investigated by means of the least-squares method. The results show that variations in the amplitude and phase of tidal tilts observed in three of four directions are ± 2-4 percent and ± 1-2° for the M_2 constituent, and ± 3-6 percent and ± 3.5° for the O_1 constituent, respectively, during the observation period. Considering the error limit in sensitivity measurements, it may be concluded that both the M_2 and O_1 tidal constants have not changed significantly during this period, suggesting no essential change of elastic properties in the shallow crust. This conclusion may be consistent with the fact that seismic activity around the region has not been so high. Successive analyses with 30-day data have also been performed by shifting the central epoch by a 2-day step, and it has become clear that there is a common periodic oscillation in the amplitudes and phases of both M_2 and O_1, but this can be easily removed by a moving-average method. It might be possible to find out more detailed variations in the tidal constants from the averaged results. References (12 items).

Kawahara, M. 1981. "Periodic Finite Elements in Two-Layer Tidal Flow," _International Journal for Numerical Methods in Fluids_, 1(1):45-61.

The aim of this paper is to present the finite element method and its application to quasi-steady periodic two-layer tidal flow in estuaries and coastal seas. Formulating the weighted residual equations, using quadratic polynomials for velocity and linear polynomials for water elevation as interpolation functions and employing the periodic Galerkin method, the nonlinear simultaneous equations can be derived. The present method is used for the simulation analysis of the Niigata Port redevelopment planning. References (26 items).

Kelley, J. T. "Composition and Origin of the Inorganic Fraction of Southern New Jersey Coastal Mud Deposits." (See complete entry in Section II.)

Kieslich, J. M. "A Case History of Port Mansfield Channel, Texas." (See complete entry in Section II.)

Kieslich, J. M. "Tidal Inlet Response to Jetty Construction." (See complete entry in Section V.)

King, H. L., Scott, M. A., and Smith, T. J. "Some Remarks on the Analysis of Short Tidal Records." (See complete entry in Section VIII.)

Kirby, R., and Parker, W. R. "A Suspended Sediment Front in the Severn Estuary." (See complete entry in Section II.)

Kjerfve, B. "Calibration of Estuarine Current Crosses." (See complete entry in Section VII.)

Kjerfve, B., ed. _Estuarine Transport Processes_. (See complete entry in Section II.)

Knight, D. W. "Some Field Measurements Concerned with the Behaviour of Resistance Coefficients in a Tidal Channel." (See complete entry in Section VIII.)

Knight, D. W., et al. "The Measurement of Vertical Turbulent Exchange in Tidal Flow." (See complete entry in Section VII.)

Knowles, C. E. "Estimation of Surface Gravity Waves from Subsurface Pressure Records for Estuarine Basins." (See complete entry in Section VII.)

Komar, P. D. 1976. _Beach Processes and Sedimentation_, Prentice-Hall, Inc., Englewood Cliffs, N. J.

The book has an introductory chapter that includes a description of the uses of

beaches, the various disciplines that study beaches, and pertinent literature sources. Chapter Two deals with coastal geomorphology and presents the general terminology that will be needed throughout the remainder of the book. Because there are other books already available on coastal geomorphology, the length of Chapter Two was kept short on purpose. The next few chapters deal with nearshore processes: water waves (their generation, travel, refraction, and breaking); tides and longer-term sea level changes; long-shore current generation and prediction; and sand transport on beaches. The subsequent chapters deal with the response of the beach to these processes; shoreline configuration, including the variety of rhythmic shoreline forms; the beach profile; and the effects of constructing engineering structures in the nearshore and how this alters the equilibrium. The final chapter deals principally with the geological aspects of beach sedimentation, including what governs the composition of the beach, the roundness and shape of its grains, the many sedimentary structures found there, and the organisms found in the nearshore and how they affect the sedimentation. It ends with a summary discussion, including examples, of the identification of ancient beach deposits in the geologic rock record. References (215 items).

Kraft, J. C., John, C. J., and Maurmeyer, E. M. "Morphology of Coastal Barriers, Delaware, U.S.A." (See complete entry in Section II.)

Krause, G. "Separation of Climatic Fluctuations and Impacts of Engineering Activities in Estuaries." (See complete entry in Section III.)

Kuo, C. Y., and Blair, C. H. "Comparison of Verified Physical and Mathematical Model." (See complete entry in Section VI.)

Lai, C. "A Computer Simulation Study of Traveltimes of Injected Particles and Tide-Waves in Well-Mixed Estuaries." (See complete entry in Section VI.)

Lai, C. "Computer Simulation of Two-Dimensional Unsteady Flows in Estuaries and Embayments by the Method of Characteristics: Basic Theory and the Formulation of the Numerical Method." (See complete entry in Section VI.)

Lai, C. "The Boundary Conditions in the Implicit Solution of River Transients." (See complete entry in Section VI.)

Lara-Lara, J. R., Alvarez-Borrego, S., and Small, L. F. 1980. "Variability and Tidal Exchange of Ecological Properties in a Coastal Lagoon," *Estuarine and Coastal Marine Science*, 11(6):613-637.

Sea level, current velocity, temperature, salinity, oxygen, inorganic phosphate, chlorophyll a, seston and its organic and inorganic fractions, phytoplankton species abundance, particulate organic carbon and nitrogen, and primary productivity time series were generated for the mouth of San Quintin Bay, Baja California, Mexico, for 18 days during the summer of 1977. This was done to elucidate the main factors that cause variability of these ecological properties and to frame some generalizations about the offshore waters during the summer season. San Quintin Bay is of considerable interest because of its developing mariculture potential, and because it is representative of a type of coastal lagoon that is rapidly being altered by man's activities. Alternation of upwelling events was the main cause of variability for all properties except temperature. Semidiurnal tides were the main cause of variability for temperature. Conservative variables such as temperature and salinity had a semidiurnal component greater than the diurnal one. Most nonconservative variables (chlorophyll a and phosphate concentrations, for example) had equal diurnal and semidiurnal variability components, due to biological processes that strongly depend on the solar radiation cycles. The relationship between variability components for oxygen was intermediate to those relationships for the conservative and nonconservative variables. Seston variability was mainly due to turbulence induced by winds and tidal currents. Lack of correlation between particulate organic carbon and nitrogen, and the wide range of C:N ratios in particles, indicate that bay-derived seston of widely varying organic and inorganic content represents most of the suspended particulate matter. Mean transports of all properties measured at the bay mouth, over the complete sampling period and within each upwelling event, were positive, indicating net movement into the bay. During the second upwelling event (the last 7 days of the sampling period), mean fluctuation fluxes for temperature, oxygen, and chlorophyll a at the bay mouth were significantly negative, indicating exports of these properties from the bay. For all other variables, and during the first upwelling period and the upwelling relaxation period, there were no significant fluctuation fluxes at the bay mouth. Diatoms were always the most abundant phytoplankton group. Primary productivity was always greatest at the surface, with a mean value of 27 mg C m^{-3} h^{-1} through the sampling period. Maximum surface productivity values were obtained for the upwelling relaxation period (up to 44 mg C m^{-3} h^{-1}). A mean value of 122 mg

C m^{-2} h^{-1} was found for the entire water column during the 18-day period. These values are comparable to the productivity maxima of other upwelling areas. The mean surface assimilation ratio was 6.6 mg C (mg chl a)$^{-1}$ h^{-1}, which indicates nutrient-rich waters. References (45 items).

Lees, B. J. "Observations of Tidal and Residual Currents in the Sizewell-Dunwich Area, East Anglia, U.K." (See complete entry in Section VIII.)

Lees, B. J., and Heathershaw, A. D. "Sizewell-Dunwich Banks Field Study, Topic Report 5; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data." (See complete entry in Section II.)

Lepetit, J. P., and Davesne, M. "Dynamics of Silt in Estuary, Residual Current or Flocculation Which Prevails?" (See complete entry in Section II.)

Lepetit, J. P., and Hauguel, A. "A Numerical Model for Sediment Transport." (See complete entry in Section II.)

Le Provost, C. "A Model for Prediction of Tidal Elevations Over the English Channel." (See complete entry in Section VI.)

Le Provost, C., and Poncet, A. 1978. "Finite Element Method for Spectral Modelling of Tides," _International Journal for Numerical Methods in Engineering_, 12(5):853-871.

A spectral method for modelling of tides is proposed and applied to the calculation of the M$_2$ component of the tide in the English Channel. The classical nonlinear hyperbolic problem of long wave propagation in shallow waters is transformed into a sequence of elliptic problems by looking at a multiperiodic solution the frequencies of which are previously known. The method is based upon a perturbation technique, but the principal difficulties arise from the nonanalytical form of the quadratic friction term: the main conclusions of the corresponding study only are given here because the purpose of this paper is to present a practical application of the method to the calculation of a tidal component by the finite element method. The variational formulation of the problem is presented and the finite element package used is described. Some results are given for the M$_2$ tide in the English Channel: cotidal maps and current fields. References (10 items).

Lewis, R. E., and Lewis, J. O. "The Principal Factors Contributing to the Flux of Salt in a Narrow, Partially Stratified Estuary." (See complete entry in Section III.)

Lie, H.-J., and El-Sabh, M. I. "Formation of Eddies and Transverse Currents in a Two-Layer Channel of Variable Bottom with Application to the Lower St. Lawrence Estuary." (See complete entry in Section VI.)

Lin, P., Dai, Z., and Li, K. 1982. "Unsteady Flow Studies in China," _Journal, Waterway, Port, Coastal and Ocean Division_, ASCE, 108(WW3):343-360.

This article summarizes some results of research on unsteady flow problems encountered in China. These results are in general little known to the world outside of China. The report is not intended to be general, although it does touch on considerable variety of problems, such as one- and two-dimensional tidal flow in estuaries, dam-break waves, routing of suspended load, and prediction of salinity. References (21 items).

Lin, P., and Shen, H. "Two-D Flow with Sediment by Characteristics Method." (See complete entry in Section II.)

Lin, W.-M. 1978. "The Harmonic Analysis of 25 Hours Tidal Current Observation," _Proceedings, International Conference on Water Resources Engineering_, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:331-341.

The harmonic analysis of tidal current data of a short observational period is proposed. The presented method is based on the least-squares method, which has been conventionally used for the harmonic analysis of the tides, as well as on the equilibrium tide theory. By this method, the harmonic constants concerning tidal currents of ten constituents can be computed from 25-hour observations. The probable error is also discussed. References (9 items).

Liou, Y.-C., and Herbich, J. B. "Velocity Distribution and Sediment Motion Induced by Ship's Propeller in Ship Channels." (See complete entry in Section II.)

Liu, S. K., and Leendertse, J. J. "Three-Dimensional SGC Energy Model of Eastern Bering Sea." (See complete entry in Section VI.)

Lundgren, H. 1978. "Struggle of Physics and Mathematics," _Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany_, ASCE, I:13-24.

This paper gives examples of the separate and combined efforts of physics and mathematics in coastal engineering with

particular reference to the possibilities in the future. It points to the fact that physical thinking is necessary as an inspiration to mathematical and numerical work. While there is relatively little duplication of work (among the various institutions) of a purely theoretical character, the same statement does not apply to numerical models. One may hope that the future will produce more coordination in this respect. There are two disciplines where the establishment of high-quality numerical models will require a particularly strong combination of basic research, numerical expertise, and fieldwork: three-dimensional mixing processes and sediment problems. It would seem that no single institution has available both the integrated expertise and the capital investment required. Hence, a close cooperation among several institutions is almost mandatory.

McAnally, W. H., Jr., and Raney, D. C. "Los Angeles Harbor and Long Beach Harbor: Physical and Numerical Tidal Models: A Comparison." (See complete entry in Section VI.)

McAnally, W. H., Jr., et al. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth." (See complete entry in Section VI.)

MacArthur, R. C. 1979. "Turbulent Mixing Processes in a Partially Mixed Estuary," Ph. D. Dissertation, University of California, Davis.

Analyses of observed half-hourly data collected from the Savannah River estuary have provided a better understanding of several of the complex mixing processes occurring in partially mixed estuaries. A method of estimating the nature and magnitude of the parameters which describe the flow, in the region near the bed, located below the maximum density gradient in partially mixed estuaries is developed and validated. Accurate determination of these parameters allows the calculation of the vertical profiles of velocity and an estimation of the vertical turbulent mixing coefficients within this region. Calculated values of the local bed shear stress obtained from numerically integrating a form of the two-dimensional momentum equation were found to be accurate when compared to the measured sediment bed shear strengths for various orders of aggregation throughout a mean tide. Orderly flows occur during specific periods of time during a tidal cycle and only within certain vertical regions of the flow within the Savannah estuary. Criteria are developed to be able to identify these periods of "fully developed" flow. Vertical distributions of velocity, shearing stress, and turbulent exchange coefficients are derived from Prandtl and von Karman forms of the "mixing length theory." These relations are applied and validated with observed data from the Savannah estuary. Two distinct regions of flow separated by a central mixing zone are identified and analyzed for their individual hydrodynamic properties. Couette flow characteristics and those properties typically found in "drag-reducing" flows are identified and analyzed within the "near-bed" region. Values of von Karman's constant, k, are observed to be reduced by the presence of stable density gradients and high concentrations of suspended sediment. A variable form of von Karman's constant k/ϕ is developed for the near-bed region based upon a modified form of the Monin-Obukhov stability function $\phi(\zeta)$. Calculated values of this effective von Karman's parameter k/ϕ tended to an average value of 0.2. Observed vertical profiles of velocity and eddy viscosity are successfully reproduced using theoretical relationships which incorporate the newly defined effective von Karman's parameter k/ϕ. A simple linear relationship is found to exist between the near-bed layer turbulent Schmidt number and Reynolds number. This relationship confirms results obtained from dimensional analyses and compares closely with previous results observed in laboratory flumes by Orlob. Observation of logarithmic velocity profiles, constant shearing stress distributions, and simple linear Schmidt to Reynolds number relationships within the near-bed region indicates that boundary-layer type flows exist during periods of fully developed flow in partially mixed estuaries. Results from the analyses reported herein indicate that the presence of stable density gradients and high concentrations of suspended sediment require the modification of fundamental turbulent flow relationships in order that observed local flow characteristics be accurately described. References (210 items).

MacAyeal, D. R. "Numerical Simulations of the Ross Sea Tides." (See complete entry in Section VI.)

McCann, S. B., Reinson, G. E., and Armon, J. W. 1977. "Tidal Inlets of the Southern Gulf of St. Lawrence, Canada," Coastal Sediments '77, Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Charleston, South Carolina, November 2-4, 1977, ASCE, 504-519.

Barrier islands and sandspits, cut by numerous tidal inlets, are an important element of the coastline of the southern Gulf of St. Lawrence, which had been little studied prior to 1970. However, recent investigations by the authors and

others have provided a basic understanding of the morphology and dynamics of the barrier systems and some of the principal inlets. Only one of the inlets, Portage Channel at the entrance to the Miramichi estuary, is utilized by oceangoing vessels, to reach the New Brunswich ports of Chatham and Newcastle, but there are numerous small craft harbors situated inside the barriers all around the southern Gulf. Thus, many of the inlets are heavily utilized by small fishing vessels, and periodic dredging of inlet and lagoon channels is necessary. The present paper examines shoreline and inlet conditions along the northeast coast of New Brunswick, in particular at the entrance to the Miramichi estuary, and along the Malpeque shore of Prince Edward Island. The two areas illustrate the range of conditions in terms of littoral drift rates, inlet size and stability, and associated sand bodies which are typical of the region. The Gulf of St. Lawrence is a "protected sea," microtidal coastal environment, in which normal shore processes are curtailed for more than 3 months each year due to the presence of pack and shorefast ice. Swell waves from the North Atlantic enter the southern Gulf for only 7 percent of the year; the wave climate is dominated by waves generated across the relatively short fetches of the Gulf itself. Wind fetches are generally less than 200 km, except for the narrow fetch "window" (500-700 km) to the northeast. The waves are generally steep with short wavelengths in relation to wave height. Wave periods over 9.5 sec and wave heights over 5 m are uncommon. The tides are mixed diurnal to semidiurnal in character, and the small tidal range restricts wave action vertically. Mean tidal range at Portage Island on the Miramichi barrier is 1.1 m, and at Malpeque is 1.2 m. References (16 items).

McCave, I. N., and Geiser, A. C. "Megaripples, Ridges and Runnels on Intertidal Flats of the Wash, England." (See complete entry in Section VIII.)

McClimans, T. A., and Gjerp, S. A. "Numerical Study of Distortion in a Froude Model." (See complete entry in Section VI.)

Macdonald, G. J., and Weisman, R. N. "Oxygen-Sag in a Tidal River." (See complete entry in Section IV.)

Machemehl, J. L., and Gopalakrishnan, T. C. "Comparison of Numerical Simulation Flow Models for Coastal Inlets." (See complete entry in Section VI.)

Magnell, B. A., et al. 1980. "The Relationship of Tidal and Low-Frequency Currents on the North Slope of Georges Bank,"

Journal of Physical Oceanography, 10(8):1200-1212.

Measured currents at the steeply sloping north edge of Georges Bank show an unusually strong correlation between tidal and lower frequency components. The dominant current constituents are the rotary semidiurnal tides (amplitude ~30 cm s^{-1}, ellipticity 0.6) and the mean isobath-parallel flow to the northeast (ranging from zero to 40 cm s^{-1}). At the middle water depth in the period range of 3-5 days, the along-isobath low-frequency current component is highly coherent ($\gamma^2 > 0.8$) with the amplitude of the semidiurnal tidal current. The fact that variation of the tidal current amplitude occurs on time scales appropriate to wind-driven events suggests that the tidal structure must be significantly baroclinic, and this is supported by hydrographic data. The evidence thus suggests a local nonlinear interaction between tidal and low-frequency currents, with both the steep bottom topography and the density structure being important factors. References (7 items).

Maier-Reimer, E. "Residual Circulation in the North Sea Due to the M_2-Tide and Mean Annual Wind Stress." (See complete entry in Section VI.)

Marche, C. "Stability Study of an Artificial Salt Intrusion in Estuaries." (See complete entry in Section III.)

Matsunaga, K., et al. "Behavior of Organically-Bound Iron in Seawater of Estuaries." (See complete entry in Section III.)

Maxworthy, T. "A Note on the Internal Solitary Waves Produced by Tidal Flow over a Three-Dimensional Ridge." (See complete entry in Section VI.)

Milliman, J. D., et al. "Tidal Phase Control of Sediment Discharge from the Yangtze River." (See complete entry in Section II.)

Mills, D. A., Colman, R. S., and Dandy, G. C. "Water Movement in a Complex Estuarine Embayment--A Methodology for Data Collection and Analysis." (See complete entry in Section VII.)

Monahan, D. "Morphology and Sediments of Sand Waves in the St. Lawrence Estuary." (See complete entry in Section II.)

Montgomery, J. R. "Predicting Level of Dissolved Reactive Phosphate in the Lafayette River, Virginia, from Information on Tide, Wind, Temperature, and Sewage Discharge." (See complete entry in Section IV.)

Morris, F. W., IV, Walton, R., and Christen-
sen, B. A. "Point and Nonpoint Pollutant
Flushing in Tidal Canal Networks." (See
complete entry in Section IV.)

Muench, R. D., and Coachman, L. K. 1980.
"Energy Balance in a Highly Stratified
Embayment: Norton Sound, Alaska,"
Proceedings, Second International Sym-
posium on Stratified Flows, The Norwegian
Institute of Technology, Trondheim, 24-27
June 1980, Torkild Carstens and Thomas
McClimans, ed., 1:515-526.

Norton Sound is a broad, shallow subarctic
coastal embayment indenting the Alaskan
coast in the northeastern Bering Sea. The
eastern portion of the sound contains in
summer a strongly two-layered hydrographic
structure, with the interface between
layers the focus of extreme vertical gra-
dients in temperature, salinity, and den-
sity. The layering persists through the
summer despite shallow depths (15-20 m)
and vigorous tidal currents (~20 cm
sec^{-1}). Presence of the layering reflects
an unusual balance between buoyancy input
and turbulent mixing. Buoyancy additions,
primarily from local freshwater addition
and solar insolation, are confined almost
entirely to the upper layer, due to the
marked suppression of vertical turbulence
by the extreme pycnocline, abetted by the
sluggish horizontal circulation of the
upper layer and near-zero mean flow of the
lower. Energy for turbulent mixing comes
almost entirely from tidal dissipation and
is largely confined to the lower layer.
Rates of these energy additions are esti-
mated for a summer period. In other
coastal regions, 1-2 percent of the tidal
dissipation has been found adequate to
vertically mix the water columns; in Nor-
ton Sound buoyancy addition is ~5 percent
of tidal dissipation, an unusually large
value sufficient to form and maintain the
observed two-layered structure in the
presence of substantial tidal mixing
energy. References (15 items).

Muir, L. R. 1980. "Internal Tides in a
Partially-Mixed Estuary," Proceedings,
Second International Symposium on Strati-
fied Flows, The Norwegian Institute of
Technology, Trondheim, 24-27 June 1980,
Torkild Carstens and Thomas McClimans,
ed., 1:538-547.

In 1974, 1975, and 1977, measurements of
temperature, salinity, and velocity were
carried out on the Middle Estuary of the
St. Lawrence River in order to provide
information on the primary physical pro-
cesses controlling the circulation of this
partially-mixed estuary. An examination
of the 44 current meter records showed
that, in addition to the barotropic tidal
currents, it would also be necessary to
include baroclinic tidal currents in any
explanation of the velocity structure.

The 66 tidal profiling stations provided
enough density information to show that
the tidally averaged density structure in
the estuary could be expressed in the form
$\bar{\rho}(x,y,z) = a_1(x,y) \exp (a_2/z+a_3)$, where
a_2 and a_3 are constants throughout the
Middle Estuary. It was not possible to
provide an analytical form for $a_1(x,y)$,
but there was enough information to show
that there are large horizontal density
gradients present and that the effect of
these tidally averaged horizontal density
gradients on the observed instantaneous
density structure must be accounted for.
Using the baroclinic structure derived
from the tidally averaged vertical density
structure and the presence of horizontal
density gradients which are advected back
and forth in the estuary, a set of predic-
tion equations is developed. These equa-
tions allow the prediction of the instan-
taneous densities and velocities that
would be measured by an instrument fixed
to the bottom of the estuary. The results
of applying these equations to a hypothet-
ical channel, somewhat like the St. Law-
rence, result in instantaneous density and
velocity profiles very like those ob-
served. It is not possible to ignore
either of these effects, and still get
results that look like the observations.
It is suggested that the concepts devel-
oped here have application in many
partially-mixed estuaries besides the
St. Lawrence. References (14 items).

Muralikrishna, I. V., and Devanathan, R.
"Circulation and Salinity Distribution in
Coastal Inlets." (See complete entry in
Section VI.)

Murty, T. S., and Henry, R. F. "Tides in
the Bay of Bengal." (See complete entry
in Section VIII.)

Najarian, T. O., Wang, D-P., and Huang, P-S.
"Lagrangian Transport Model for Estu-
aries." (See complete entry in Sec-
tion VI.)

Nakagawa, T., and Hinwood, J. B. "A Pro-
posed Model of Large Scale Cellular Motion
in Strong Tidal Flows." (See complete
entry in Section VI.)

Nasner, H. "Time-Lag of Dunes for Unsteady
Flow Conditions." (See complete entry in
Section II.)

Nece, R. E., and Forsyth, G. W. 1980.
"Annotated Bibliography on Tidal Flushing
and Circulation in Marinas," Technical
Report No. 67, Charles W. Harris Hydraulic
Laboratory, University of Washington,
Seattle.

The bibliography presented in this report
includes papers, reports, etc., under the
following headings: Tidal Flushing and

Circulation, Physical Hydraulic Model
Studies, Numerical Models, Sedimentation
Problems, Water Quality (Field Investiga-
tions), Environmental Impact Statements,
and Literature Review.

Nece, R. E., and Scheffner, N. W. "Field
Data Analysis for Chesapeake Bay Model
Verification." (See complete entry in
Section VIII.)

Nece, R. E., and Smith, H. N. "Tidal Ex-
change in Proposed Sitka, Japonski Lagoon,
Small Boat Harbor." (See complete entry
in Section VI.)

Nece, R. E., et al. "Effects of Planform
Geometry on Tidal Flushing and Mixing in
Marinas." (See complete entry in Sec-
tion VI.)

Nelson, R. C., and Keats, A. J. 1980. "A
Coastal Inlet with Fixed Bed and Mobile
Sides," Proceedings, Seventeenth Coastal
Engineering Conference, March 23-28, 1980,
Sydney, Australia, ASCE, III:2534-2549.

The coastal inlet dealt with in this paper
has a fixed bed of exposed rock and mobile
side boundaries of sand that overlie the
bedrock platform. The work was undertaken
to investigate the response of the throat
section to natural hydraulic and meteoro-
logical events and to observe the nature
and rate of recovery of the inlet after
the more extreme events. These events in-
cluded sea and swell states, wind, fresh-
water flood flows, and short-term changes
in mean sea level (storm surges or meteor-
ological tides). The 3-year study in-
volved the inlet at the mouth of the Bar-
won River, Victoria, Australia. The work
forms part of a continuing study to assess
the impact of engineering works on the
stability of the estuary and inlet, and
was required to assist in delineating the
natural inlet variability from that due to
engineering works. The study described
here looked specifically at the inlet
throat section which refers to the short
narrow waterway connecting the estuary
with the sea. The inlet throat section at
Barwon Heads is well defined. The inlet
itself is free of training walls and is
normally flanked by sandy beaches. How-
ever, the depth of the inlet is limited by
a bed of rock, there being, in effect,
unlimited mobility on a side boundary
only. The study therefore included an in-
vestigation to see if such an inlet con-
formed to equilibrium criteria developed
from inlets with unrestricted bed mobil-
ity. Some results of previous investiga-
tions on the estuary and inlet were re-
ported by Nelson (1977). References
(5 items).

Nielsen, A. F., and Gordon, A. D. 1980.
"Tidal Inlet Behavioural Analysis."

Proceedings, Seventeenth Coastal Engi-
neering Conference, March 23-28, 1980,
Sydney, Australia, ASCE, III:2461-2480.

For many years stability theories have
been used both to design inlets and to
appraise the performance of them. There
are a variety of approaches to the formu-
lation of stability criteria ranging
from the purely empirical (Stevenson,
1884, cited by Bruun and Gerritsen, 1958;
O'Brien, 1931; Bruun, 1977) to the gener-
alized analytical (Escoffier, 1940; Bruun
and Gerritsen, 1958; Keulegan, 1967;
O'Brien and Dean, 1972). In 1966 a seem-
ingly small perturbation made to the inlet
of Wallis Lake resulted in significant
changes to the estuary. The direct appli-
cation of existing stability theories was
of marginal value in explaining these
changes and predicting the stable regime
that the estuary may ultimately reach.
This paper highlights some of the limit-
ations of existing stability theories,
presents a new method of dynamic behavi-
oural analysis, outlines the case study of
an estuary to which existing stability
theories could not be effectively applied
but to which the behavioural analysis
produced interesting results, and recom-
mends the direction in which further re-
search could yield beneficial results.
References (13 items).

Nihoul, J. C. J., ed. 1979. Marine Fore-
casting; Predictability and Modelling in
Ocean Hydrodynamics; Proceedings, 10th
International Liège Colloquium on Ocean
Hydrodynamics, Elsevier Oceanography
Series 25, Elsevier, Amsterdam.

The papers presented report fundamental
and applied research and address such dif-
ferent fields as storm surges, mixing in
the upper ocean layers, surface waves, cy-
clogenesis, and other air-sea or sea-air
interactions. Most of the papers contain
well-documented case studies or applica-
tions of mathematical models to the fore-
casting of marine hydrodynamics. Partial
content: "Non-Linear Three-Dimensional
Modelling of Mesoscale Circulation in Seas
and Lakes" by J. C. J. Nihoul, Y. Runfola,
and B. Roisin, References (24 items); "Re-
cent Storm Surges in the Irish Sea" by
N. S. Heaps and J. E. Jones, References
(8 items); "Extratropical Storm Surges in
the Chesapeake Bay" by D.-P. Wang, Ref-
erences (6 items); "First Results of a
Three-Dimensional Model on the Dynamics in
the German Bight" by J. Backhaus, Refer-
ences (8 items); "Tidal and Residual Cir-
culations in the English Channel" by F. C.
Ronday, References (16 items); "Recent Re-
sults from a Storm Surge Prediction Scheme
for the North Sea" by R. A. Flather, Re-
ferences (20 items); "Belgian Real-Time
System for the Forecasting of Currents and
Elevations in the North Sea" by Y. Adam,
References (24 items); "Oceanography at

Forecast of Dramatic Water Elevations in Venice" by A. Tomasin and R. Frassetto, References (21 items); "The Response of the Coastal Waters of N. W. Italy" by A. J. Elliott, References (11 items); "A Numerical Model for Sediment Transport" by J. P. Lepetit and A. Hauguel, References (5 items); "Security of Coastal Nuclear Power Stations in Relation with the State of the Sea" by J. Bernier and J. Miquel, References (5 items).

Nishimura, J. K., and Lau, L. S. "Structure for Automatic Opening of Closed Stream Mouths." (See complete entry in Section V.)

Noble, M., Butman, B., and Williams, E. 1983. "On the Longshelf Structure and Dynamics of Subtidal Currents on the Eastern United States Continental Shelf," _Journal of Physical Oceanography_, 13(12):2125-2147.

Strong correlations were observed among subtidal longshelf currents from the Middle Atlantic Bight (MAB) to the Georges Bank region, a distance spanning 615 km. The longshelf current consisted predominantly of wind-forced motions and freely propagating events, which together accounted for 75-90 percent of the longshelf current energy. Much stronger longshelf currents were observed in the MAB than on Georges Bank. The MAB/Georges Bank energy ratio for wind-forced currents on the 60-m isobath was 20. The ratio for freely propagating events was 3. The magnitudes of many of the terms in the vertically integrated wind-driven momentum equations were estimated from observations of current pressure, and surface stress, and from calculations of bottom stress. The cross-shelf momentum balance was geostrophic. Surface and bottom stress, the longshelf pressure gradient, and the Coriolis force on the cross-shelf flow were important terms in the longshelf momentum balance. An analytic model of wind-forced current, which incorporates the significant force balances, accounted for the observed longshelf variation of the wind-forced currents. Average bottom-drag and bottom-resistance coefficients estimated from current and bottom-stress records range from 4-8 ($\times 10^{-3}$) and 0.07-0.20 cm s^{-1}, respectively. References (26 items).

Nof, D. "On Geostrophic Adjustment in Sea Straits and Wide Estuaries; Theory and Laboratory Experiments, Part I: One-Layer System." (See complete entry in Section VI.)

Novak, P., and Čabelka, J. _Models in Hydraulic Engineering; Physical Principles and Design Applications_. (See complete entry in Section VI.)

Nummedal, D., and Fischer, I. A. "Process Response Models for Depositional Shorelines: The German and the Georgia Bights." (See complete entry in Section II.)

O'Brien, M. P. 1980. "Comments on Tidal Entrances on Sandy Coasts," _Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia_, ASCE, III:2504-2516.

The areas discussed in these comments include flow area-tidal prism, hydraulic characteristics, stability of inlets, and inlet closure. References (24 items).

O'Connor, D. J., and Lung, W. "Suspended Solids Analysis of Estuarine Systems." (See complete entry in Section VI.)

Odd, N. V. M. 1979. "Significance of Long-Period Tidal Oscillations in Estuaries," HRS Notes, Hydraulics Research Station, Wallingford, Oxfordshire, England, 21:7.

A brief description is presented of the application of a mathematical model to M_f or MS_f tides (periods of 14-15 days) in the Gambia Estuary. References (2 items).

Odd, N. V. M. 1978. "Vertical Mixing in Stratified Tidal Flows," _Journal, Hydraulics Division_, ASCE, 104(HY3):337-352.

A set of mixing length functions based on an adaption of the theories of Prandtl, Rossby, Montgomery, and Ellison is presented as a means of calculating the internal shear stresses and vertical flux of solutes in gradually varying turbulent stratified tidal flows. Field observations, made in a straight canalized reach of an estuary, were used to determine the best-fit values of empirical coefficients in generalized relationships between the mixing lengths and gradient Richardson number. The main purpose of the research was to improve the representation of vertical exchange processes in mathematical models of estuaries. References (11 items).

Officer, C. B. "Tidal Exchanges and Far Field Effects." (See complete entry in Section IV.)

Officer, C. B., and Lynch, D. R. "Dynamics of Mixing in Estuaries." (See complete entry in Section III.)

O'Kane, J. P. "On the Choice of Boundary Conditions for One-Dimensional Models of Estuarine Water Quality." (See complete entry in Section VI.)

Onishi, S., and Nishimura, T. "Study of Vortex Current in Strait with Remote Sensing." (See complete entry in Section ...)

†Oonishi, Y. 1979. "Water Exchange Between Adjacent Vortices Under an Additional Oscillatory Flow," Journal of Oceanographical Society of Japan, 35(3-4):136-140.

It is shown that the coupling effect of the steady vortices and the Eulerian oscillatory flow yields the 8-shaped Lagrangian motion through which adjacent vortices intercommunicate, inducing water exchange between them. The water exchange coefficient is fairly large. This coupling effect is considered to play an important role in the water exchange across the narrow strait which is accompanied with a strong tidal current and a pair of tidal residual circulations.

†Oonisni, Y. "A Numerical Study on the Tidal Residual Flow." (See complete entry in Section VI.)

Orlob, G. T. "Water Quality Modeling of Estuaries." (See complete entry in Section VI.)

Outlaw, D. G. 1982. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 1, Prototype Data Acquisition and Analysis," Technical Report HL-82-2, Report 1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Prototype tidal elevation, current, and wind data were acquired and analyzed as a part of a study to evaluate the effects of the Lake Pontchartrain and Vicinity Hurricane Protection Plan on (a) tidal prism and circulation in Lake Pontchartrain, (b) hurricane surge levels in Lake Pontchartrain and vicinity, and (c) water quality in Lake Pontchartrain. Results of the analysis of prototype tidal elevation and current data will be used during verification of a numerical tidal circulation model. Data were included in the analysis from (a) an intensive tidal elevation and current data acquisition program for a duration of approximately 30 days; (b) a water quality program immediately following the intensive program, for monitoring tidal elevations, and, on a less extensive basis, currents, temperature, and conductivity in Lake Pontchartrain; and (c) a supplemental tidal elevation and current data acquisition program to provide additional data for numerical model verification. A water quality transect survey was conducted during both the intensive program and the supplemental survey for dissolved oxygen, pH, temperature, and conductivity. The intensive program also included a 25-hour current boat survey at six ranges in the tidal passes to Lake Pontchartrain and in the Inner Harbor Navigation Canal. Tidal analysis results show that the diurnal O_1 and K_1 constituents have the largest amplitude in Lakes Pontchartrain and Borgne and indicate that the diurnal tides in Lake Pontchartrain

are co-oscillating with little change in constituent amplitude over the lake. Data from the water quality program were limited due to generally low velocities in Lake Pontchartrain and low salinity levels during most of the observation period. References (9 items).

Owen, A. "Effect on the M_2 Tide of Permeable Tidal Barrages in the Bristol Channel." (See complete entry in Section VI.)

Owen, M. W., and Thorn, M. F. C. "Effect of Waves on Sand Transport by Currents." (See complete entry in Section II.)

Owens, M. "Severn Estuary--An Appraisal of Water Quality." (See complete entry in Section IV.)

Özsoy, E., and Ünlüata, Ü. 1982. "Ebb-tidal Flow Characteristics near Inlets," Estuarine, Coastal and Shelf Science, 14(3):251-263.

The characteristics of turbulent jets issuing from tidal inlets are analyzed by taking into account lateral mixing and entrainment, bottom friction, one-dimensional bathymetric changes, and ambient currents. In the absence of depth variations, the jet expansion is exponential as a result of bottom friction. Increasing depths significantly counteract the rapid expansion due to friction, and there are circumstances in which the jet can go through stages of expansion and contraction with distance. Cross-currents in the receiving water body reduce the jet expansion rate and deflect it sideways. These and other results are discussed under the light of qualitative observations. References (26 items).

Ozturk, Y. F. "Mathematical Modeling of Dispersion in Mixed Estuaries." (See complete entry in Section VI.)

Pape, E. H., III, and Garvine, R. W. "The Subtidal Circulation in Delaware Bay and Adjacent Shelf Waters." (See complete entry in Section VI.)

Partch, E. N., and Smith, J. D. "Time Dependent Mixing in a Salt Wedge Estuary." (See complete entry in Section III.)

Partheniades, E. "Ecologic and Thermal Problems in Estuaries." (See complete entry in Section IV.)

Partheniades, E. "Engineering Properties of Estuarine Sediments." (See complete entry in Section II.)

Partheniades, E., and Scarlatos, P. 1978. "Validity of Harmonic Approximation in Rectangular Channels Subject to

Co-Oscillating Tides," Proceedings, International Conference on Water Resources Engineering, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:315-330.

The harmonic approximation of tides has been applied to a number of rectangular closed-end channels where the real flow conditions are assumed to be given by the finite element analysis. The main objectives of this investigation are (a) the correlation of the amplitude-damping coefficient μ and of the wave number k with the channel friction coefficient, the channel dimensions, and the relative amplitude, and (b) the deviation between the values of tides and tidal velocities as predicted by the harmonic approximation and by the finite element analysis. The first conclusive results of this study are presented in this paper. References (3 items).

Pearce, B. R., Fidler, B. R., and Humphreys, A. C. "A 3-D Model for Penobscot Bay, Maine." (See complete entry in Section VI.)

Pearson, C. 1979. "Far-Field Matching for Tidal Calculations in Nearshore Regions," WSG 79-1, Department of Oceanography Contribution 1061, University of Washington, Seattle.

Tidal current calculations in bays and estuaries show that the solution is sensitive to the tidal boundary condition imposed at the mouth of the bay. The difficulty is resolved by replacing the boundary condition at the mouth of the bay by a matching requirement between far field and nearshore solutions; for tidal problems, such a procedure is complicated by the importance of the Coriolis term as well as by bathymetric and topographic complexities. A number of matching methods which can be used are described. These methods are based on integral equation, finite elements, variational methods, transform methods, series solution, or on a combination of such methods. References (8 items).

Pethick, J. S. "Long-Term Accretion Rates on Tidal Salt Marshes." (See complete entry in Section II.)

Pethick, J. S. "Velocity Surges and Asymmetry in Tidal Channels." (See complete entry in Section VI.)

Petrie, B., and Drinkwater, K. 1978. "Circulation in an Open Bay," Journal of the Fisheries Research Board of Canada, 35(8):1116-1123.

The circulation of St. Georges Bay, Nova Scotia, under stratified conditions is

presented. The mean surface circulation is characterized by a clockwise eddy with velocities of about 10 cm/s. Bottom (30-m) flow at the mouth is found to be <2 cm/s out of the bay. Depth-averaged currents still exhibit the clockwise eddy. References (8 items).

Philip, N. A. 1978. "Coastal Processes and the Wagonga Inlet Breakwaters," Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:201-206.

It was anticipated that construction of breakwaters at the entrance to the Wagonga estuary (south coast, New South Wales) would cause considerable local changes to the area by interference with the coastal processes. The coastal processes and the subsequent effects were postulated, and a comprehensive data collection program was implemented. Beach, offshore, and estuary channel sand movements were monitored, tidal level variations measured, regular vertical aerial photography flown, and sediment samples taken. A sediment budget for the monitored area was developed, and the morphological effects of the breakwaters were demonstrated. The hydraulic data is yet to be reduced and interpreted. The applicability of the extensive data collected to more general research problems involving onshore/offshore transfer, sand transport in estuaries, has not yet been explored. References (3 items).

Pickett, E. B., and Greer, H. C. "Los Angeles Harbor and Long Beach Harbor: Prototype Data Acquisition and Observations." (See complete entry in Section VIII.)

Pickrill, R. A., Irwin, J., and Shakespeare, B. S. "Circulation and Sedimentation in a Tidal-Influenced Fjord Lake: Lake McKerrow, New Zealand." (See complete entry in Section II.)

Pingree, R. D., and Griffith, D. K. "A Numerical Model of the M_2 Tide in the Gulf of St. Lawrence." (See complete entry in Section VI.)

Praagman, N. "Comparison of Numerical Models for the Computation of Residual Currents in Coastal Seas." (See complete entry in Section VI.)

Prandle, D. "Co-Tidal Charts for the Southern North Sea." (See complete entry in Section VIII.)

Prandle, D. "Hydrodynamic Modelling of the Southern North Sea." (See complete entry in Section VI.)

Prandle, D. "Modelling of Tidal Barrier Schemes; An Analysis of the Open-Boundary Problem by Reference to AC Circuit Theory." (See complete entry in Section VI.)

Prandle, D., and Wolf, J. "The Interaction of Surge and Tide in the North Sea and River Thames." (See complete entry in Section VI.)

Price, W. A., Motyka, J. M., and Jaffrey, L. J. "The Effect of Offshore Dredging on Coastlines." (See complete entry in Section V.)

Pritchard, D. W. "Hydrodynamics Models; Section 1: Three-Dimensional Models." (See complete entry in Section VI.)

Pritchard, D. W. "Hydrodynamics Models; Section 2: Two-Dimensional Models." (See complete entry in Section VI.)

Proehl, J. A., and Rattray, M., Jr. "Low-Frequency Response of Wide Deep Estuaries to Non-Local Atmospheric Forcing." (See complete entry in Section VI.)

Provis, D. G., and Lennon, G. W. "Eddy Viscosity and Tidal Cycles in a Shallow Sea." (See complete entry in Section VI.)

Pruszak, Z., and Zeidler, R. B. "Sediment Transport and Ripples Due to Waves and Currents." (See complete entry in Section II.)

†Pugh, D. 1974. "High Tides," New Scientist, 63:152.

Author discusses a previous comment by F. J. Wood concerning observed peak water levels during the period 9-12 January and 9-11 February 1974 on the south coast of England. In the surge levels the contributions by barometric surge and the residual wind surge are discerned. Reference (1 item).

Pugh, D. T., and Rayner, R. F. 1981. "The Tidal Regimes of Three Indian Ocean Atolls and Some Ecological Implications," Estuarine, Coastal and Shelf Science, 13(4):389-407.

Coral atolls are areas of high biological productivity, supporting diverse and largely closed ecosystems. Cycling of nutrients within such systems and the input of additional nutrients from ocean waters are strongly influenced by wave and tidally induced water exchange. Tidal water exchange exerts a stabilizing effect on the physical and chemical characteristics of a lagoon. Tides affect the residence time of lagoon water, and the amount by which lagoon temperatures exceed ocean surface water temperatures, typically 2° C in cloud-free windless weather.

Lagoon excess temperatures are independent of depth but vary inversely with the tidal range, with significant spring-neap modulations, but harmonic variations of lagoon temperatures at diurnal and semidiurnal periods are small except in very shallow lagoons. The effects on lagoon winds are also small, implying that measured winds are representative of open ocean conditions. The growth and zonation of corals and other organisms inhabiting shallow reef flats may be affected by the phase of the solar semidiurnal tide (S_2), which determines the time of day at which extremely low tidal levels occur. Measurements at three Indian Ocean atolls are used to illustrate these effects. References (19 items).

Pugh, D. T., and Vassie, J. M. 1978. "Extreme Sea Levels from Tide and Surge Probability," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, I:911-930.

This paper considers a method of deriving the probability of occurrence of extreme sea levels by combining the probability functions of surge and tide. As a result, the quantity of data required is less than with traditional methods. The philosophy of the method is discussed, and the conditions under which the theory can be applied are examined. Finally, the technique is applied to a number of ports in the United Kingdom, and the results are compared with known estimates of extreme levels. References (8 items).

Ramming, H.-G. 1978. "The Influence of River Normalization on the Distribution of Tidal Currents in the River Elbe," Papers, 7th International Harbour Congress, K.V.I.V. (Royal Society of Flemish Engineers), Antwerp, Belgium, 22-26 May 1978, I:3.02/1-3.02/17.

The navigational channels in most of the tidal rivers will have to be dredged. On the one hand, ships are becoming bigger and one has to provide for sufficient depth; and on the other hand, erosion and the sedimentation of sand change the bottom topography, particularly within and near the waterway. The dredged sand must be pumped on an island or elsewhere. The deposit of sand is a permanent problem in tidal rivers with navigational channels, not only from the economical point of view but also in regard to the hydrological influence. Such changes of the bottom topography require careful consideration. The case described deals with the question whether the "Schwarztonnensand" in the river Elbe will be linked to the bank of the river or not. A two-dimensional numerical model was applied. The problem was thoroughly investigated with regard to the necessary mathematical and

hydrological conditions. The computed
tidal currents and the water levels of an
undisturbed normal tide were in good
agreement with observations. After
checking this assumption, the two above-
mentioned cases were then investigated.
The essential results are the following:
If the "Schwarztonnensand" is linked to
the bank, the tidal currents will change
their directions up to 35-40 degrees and
the magnitude of the velocities will
increase up to 35 percent. The area in
which changes occur is remarkably large
and remains nearly unchanged during a
tidal period. It may be concluded that
this part of the river Elbe is parti-
cularly sensitive to coastal structures.
In the long run, further morphological
changes may occur and influence the dy-
namic balance. The disturbances described
will not take place if there is no linkup
with the bank and no narrowing of the
river. The influences of coastal struc-
tures have to be known because the navi-
gational channel always has to be in
working condition. References (11 items).

Raney, D. C. "Los Angeles Harbor and Long
Beach Harbor: A Numerical Model for Tidal
Circulation." (See complete entry in Sec-
tion VI.)

Renger, E. 1978. "Two-Dimensional Stabil-
ity Analysis of Tidal Basins and Tidal
Flats of Larger Extent," Proceedings, Six-
teenth Coastal Engineering Conference,
August 27-September 3, 1978, Hamburg, Ger-
many, ASCE, II:1971-1985.

Stability studies of a natural tidal basin
system demand a regime-oriented analysis
and a characteristic quantification of the
morphological values. Hence it was neces-
sary to create relative form parameteriza-
tion dependent on the location by means of
a two-dimensional system of natural coor-
dinates (z = elevation , s = gully length
coordinate). The underlying logic for the
determination of the equilibrium of the
tidal basins and tidal flats is as fol-
lows: When the continuity equation for
nonsteady flow at any cross section (s_i ,
z_i) of a tidal basin within the mean tidal
range is applied, a dimensionless rela-
tionship between horizontal and vertical
cross sections (A and F) and tide-
generated mean velocities of current ($\pm u$)
and tidal rise and fall ($\pm v$) can be
derived with an accuracy of more than
90 percent:

$$\frac{u}{v} \cong \frac{A}{F}$$

The analysis of the term on the right-hand
side of this equation showed a character-
istic vertical distribution of the rela-
tionship for all investigated tidal basins
of the German Bight which look rather sim-
ilar. The reference values of the corre-

sponding relationships depend on the area
of the tidal basin (E) at MHW and the mean
tidal range (H). The influence of the
horizontal extent has been elaborated by
varying the line of intersection systemat-
ically along the gully length coordinate
(s). In addition it was possible to point
out the differences between the character-
istics of stable and (well-known) non-
stable conditions by means of a two-
dimensional analysis of the dammed-off
tidal river Eider/German Bight. The re-
lations derived may prove to be useful in
the planning of future constructions and
even in understanding and influencing the
disadvantageous changes in running sys-
tems. References (10 items).

Renger, E., and Partenscky, H. W. 1980.
"Sedimentation Processes in Tidal Channels
and Tidal Basins Caused by Artificial Con-
structions," Proceedings, Seventeenth
Coastal Engineering Conference, March 23-
28, 1980, Sydney, Australia, ASCE,
III:2481-2494.

The knowledge of morphological changes to
be expected in tidal rivers and basins as
a result of man-made constructions such as
dikes, dams, and tidal control barriers is
of high interest for future decisions in
tidal regions of agricultural and economi-
cal value. It was the aim of this paper
to present two empirical approaches by
means of which a prediction of the morpho-
logical reaction of a tidal system and an
estimate of expected sedimentation rates
are possible. By using prototype measure-
ments from the Eider River, it could be
shown that the observed sedimentation
rates were in fairly good agreement with
obtained theoretical values from the two
empirical approaches. Although further
systematic research is needed in this re-
spect, it seems that the two methods dis-
cussed in this paper promise to be a good
tool in the prediction of sedimentation
rates to be expected in tidal basins and
tidal rivers due to artificial construc-
tions in the tidal regime. References
(12 items).

Richards, D. R., and Gulbrandsen, L. F.
"Low Freshwater Inflow Study; Chesapeake
Bay Hydraulic Model Investigation." (See
complete entry in Section VI.)

Riedel, H. P., and Gourlay, M. R. 1980.
"Inlets/Estuaries Discharging into Shel-
tered Waters," Proceedings, Seventeenth
Coastal Engineering Conference, March 23-
28, 1980, Sydney, Australia, ASCE,
III:2550-2564.

Tidal prism/cross-sectional area relation-
ships and tidal velocities have been mea-
sured for inlet entrances and along the
length of the estuary for four creeks
entering the sheltered waters on the South
East Queensland coast, Australia. It has

been found that the inlet entrance tidal
prism/cross-sectional area relationship is
controlled by the magnitude of littoral
drift. The tidal prism/cross-sectional
area relationship along the estuary is
believed to be common to all tidal estu-
aries landward of the region where lit-
toral drift has an influence. For tidal
inlets on sheltered coasts with tidal
prisms of the order of 10^6 m³, the mean
maximum velocity during spring tides at
the inlet entrance is about 0.3 to
0.4 m/s. References (11 items).

Roberts, H. H. "Physical Processes and Sed-
iment Flux Through Reef-Lagoon Systems."
(See complete entry in Section II.)

Robinson, I. S. "A Tidal Flushing Model of
the Fleet—An English Tidal Lagoon." (See
complete entry in Section VI.)

Robinson, I. S., Warren, L., and Longbottom,
J. F. "Sea-Level Fluctuation in the
Fleet, an English Tidal Lagoon." (See
complete entry in Section VI.)

Rodenhuis, G. S., Kjaer, O. B., and Bertel-
sen, J. A. "A North Sea Model That Can
Provide Detailed Hydrographic Informa-
tion." (See complete entry in Sec-
tion VI.)

Rodger, J. G. "Simulation of Stratified
Flows in Estuaries." (See complete entry
in Section II.)

Scheffner, N. W., et al. "Verification of
the Chesapeake Bay Model; Chesapeake Bay
Hydraulic Model Investigation." (See com-
plete entry in Section VI.)

Schwarze, H., and Falldorf, W. "Influence
on Temperature Increases in Tidal Rivers
Caused by Waste Heat Injections with Re-
spect to Tidal Cycles and Storm Surges."
(See complete entry in Section VI.)

Seabergh, W. C. "Jetty Design for Little
River Inlet, South Carolina." (See com-
plete entry in Section V.)

Seabergh, W. C. "Model Testing of Struc-
tures at a Tidal Inlet." (See complete
entry in Section VI.)

Seabergh, W. C., and Sager, R. A. "Supple-
mentary Tests of Masonboro Inlet Fixed-Bed
Model; Hydraulic Model Investigation."
(See complete entry in Section VI.)

Seelig, W. M., and Sorensen, R. M. "Numeri-
cal Model Investigation of Selected Tidal
Inlet-Bay System Characteristics." (See
complete entry in Section VI.)

Seibert, G. H. 1980. "Tidally Forced Cir-
culation in the Saguenay Fjord," Proceed-
ings, Second International Symposium on

Stratified Flows, The Norwegian Institute
of Technology, Trondheim, 24-27 June 1980,
Torkild Carstens and Thomas McClimans,
ed., 2:647-657.

The Saguenay Fjord in Quebec branches off
the St. Lawrence Estuary at the inner end
of the Laurention channel. Two principal
sills separate the deep inner basin from
the waters of the St. Lawrence. The shal-
lowest of these sills (maximum depth of.
25 m) is located at the mouth of the
fjord. The second sill, some 22 km up-
stream from the first, is 70 m deep. As a
consequence of the high stratification,
bottom topography, and the large tidal
currents (sectional averages) of 0.5 ms⁻¹
and 0.25 ms⁻¹, one can observe a hierarchy
of internal responses. On a flooding
tide, the internal response behind the
outer sill takes on the characteristics of
a large-amplitude trapped lee wave which
can inject heavy water from sill depth to
subsurface levels. On an ebbing tide, the
flow across the outer sill seems to be
strong enough to prevent any significant
blocking, and a substantial portion of the
previous flood inflow is withdrawn to sill
level where it is mixed with low-salinity
surface waters of the fjord and the rem-
nant mixture of cold intermediate water
from the St. Lawrence Estuary remaining
over from the previous flood cycle. The
response near the inner sill is not as
strong as at the outer sill. This paper
gives a preliminary description of current
meter and CTD data obtained in the Sague-
nay Fjord. References (12 items).

Sengupta, S., Lee, S., and Bland, R. A.
"Three-Dimensional Model Development for
Thermal Pollution Studies." (See complete
entry in Section VI.)

Sengupta, S., Lee, S. S., and Miller, H. P.
"Three-Dimensional Numerical Investiga-
tions of Tide and Wind-Induced Transport
Processes in Biscayne Bay." (See complete
entry in Section VI.)

Sharp, J. J. Hydraulic Modelling. (See
complete entry in Section VI.)

Sheng, Y. P. "Mathematical Modeling of
Three-Dimensional Coastal Currents and
Sediment Dispersion: Model Development
and Application." (See complete entry in
Section VI.)

Siefert, W. 1978. "On Storm Tides in
Rivers" ("Über das Sturmflutgeschehen in
Tideflüssen"), Leichtweiss-Institut für
Wasserbau, Technischen Universität
Braunschweig, Mitteilungen No. 63:33-165
(In German).

The runoff of tide and storm surges in the
Elbe, Weser, Ems, Thames, Westerschelde,
St. Lawrence, and Delaware rivers during
the twentieth century is analyzed.

The theory includes formulas for system numbers including the damping coefficient. Factors which influence runoff are presented as changing wind conditions, increasing storm tide heights, an increase in normal tide propagation velocity due to changes in riverbeds, and propagation velocities of both mean and storm tides increasing with higher freshwater discharge, due to greater water depths. The influence of weirs in storm surges and the wind situation above tidal rivers is briefly discussed. References (45 items).

Siefert, W., and Barthel, V. 1980. "The German 'MORAN' Project," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2927-2937.

The project MORAN (Morphological Analyses of the North-Sea-Coast) is an extensive program in order to try and combine all knowledge of the morphologic behavior of a transitional zone of 5- to 7-km width with weather, tide, current, and wave data. The area to be considered is about 9,000-km² size. The program started in 1979 and will probably continue until 1984. References (7 items).

Signorini, S. R. "A Three-Dimensional, Finite Element Numerical Model of Circulation and Diffusion-Advection Processes for Estuarine and Coastal Application (With Application to Bay of Ilha Grande, Brazil)." (See complete entry in Section VI.)

Simon, M. B. "Prediction of Tidal Currents at Brest (Prédiction De La Marée À Brest)." (See complete entry in Section VIII.)

Simpson, J. E., and Britter, R. E. 1980. "Experiments on the Dynamics of the Front of a Gravity Current," Proceedings, Second International Symposium on Stratified Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:174-183.

Measurements are made of the structure and mixing at the heads of laboratory gravity currents between fresh and salt water. The currents are run at different fractional depths both by a lock-exchange method and in an apparatus in which they are brought to rest by an opposing flow. An analysis includes the observed mixing at the head and is based on a momentum balance and on the position of the stagnation point at the front of the gravity current head. Types of current considered are (a) with slip at the boundary, such as small-scale surface ocean or estuarine currents, and (b) with no slip along a horizontal floor. These are extended to include the effect of opposing and following flows, and results are compared with some corresponding flows in the ocean and in the atmosphere. References (9 items).

Simpson, J. H., Hughes, D. G., and Morris, N. C. G. 1977. "The Relation of Seasonal Stratification to Tidal Mixing on the Continental Shelf," A Voyage of Discovery; George Deacon 70th Anniversary Volume, M. Angel, ed., Pergamon Press, Oxford, 327-340.

A stratification parameter $\bar{v}$, defined as the amount of mechanical energy required to bring about vertical mixing, has been calculated for an extensive region of the shelf using available data. The distribution of $\bar{v}$ during the summer months is compared with a tidal mixing theory which suggests that the parameter h/u_s^3 (h = depth , u_s = tidal stream amplitude at springs) controls the occurrence of stratification. The results lend qualitative support to the model, although plots of $\bar{v}$ versus h/u_s^3 show a large degree of scatter which is interpreted as being largely due to variations in wind and wave mixing and surface heat input. Much of the structure of the $\bar{v}$ and h/u_s^3 distributions is apparent in recently available infrared images of the sea surface. References (6 items).

Simpson, J. H., and Nunes, R. A. 1981. "The Tidal Intrusion Front: An Estuarine Convergence Zone," Estuarine, Coastal and Shelf Science, 13(3):257-266.

Freshwater discharge in a small estuary flows seaward as a density current which is forced back into the estuary during the flood phase of the tidal streams. The development of the two-layer flow and the associated frontal structure is described. The front exhibits a V configuration with an isolated point convergence at its apex and an associated gyre system. References (9 items).

Smith, N. P. "A Comparison of Tidal Harmonic Constants Computed at and near an Inlet." (See complete entry in Section VIII.)

Smith, N. P., and Kierspe, G. H. "Local Energy Exchanges in a Shallow, Coastal Lagoon: Winter Conditions." (See complete entry in Section VI.)

Smith, R. "Effect of Salt Upon Hot-Water Dispersion in Well-Mixed Estuaries." (See complete entry in Section III.)

Smith, T. J. "On the Representation of Reynolds Stress in Estuaries and Shallow Coastal Seas." (See complete entry in Section VI.)

Smith, T. J., and O'Connor, B. A. "A Two-Dimensional Model for Suspended Sediment Transport." (See complete entry in Section VI.)

Sorensen, R. M. 1980. "The Corps of Engineers General Investigation of Tidal Inlets," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia ASCE, III:2565-2580.

During the past decade, the US Army Corps of Engineers has been conducting a General Investigation of Tidal Inlets (GITI). The GITI was an applied research program through which a wide range of inlet phenomena relating to Corps responsibilities for coastal navigation and recreation, prevention of beach erosion, and control of coastal flooding were investigated. The program was managed by the US Army Coastal Engineering Research Center (CERC); specific research projects were conducted by CERC, the US Army Engineer Waterways Experiment Station (WES), private consultants, and universities. The various GITI research efforts can be divided into five categories: (a) field studies of the hydraulics and sedimentary dynamics of selected inlets, (b) analysis of historic field data, (c) numerical models of inlet hydraulics, (d) movable- and fixed-bed physical inlet models, and (e) other miscellaneous inlet studies. Research results are being published in a special report series. The number, title, author, and date of each report are listed in the Appendix - GITI Reports. The intent of this paper is to summarize GITI research efforts and, based on key results of this research as well as recent Corps field experience, to recommend new areas for research. References (7 items).

Soulsby, R. L. 1980. "Selecting Record Length and Digitization Rate for Near-Bed Turbulence Measurements," Journal of Physical Oceanography, 10(2):208-219.

Measured values of turbulence parameters (such as mean, variance, or covariance of velocity) depend on the record length and digitization rate chosen for their computation. The following six factors, governing the accuracy of the measurements, are discussed in the context of the tidal bottom boundary level in Start Bay, southwest England: loss of low- and high-frequency contributions, stationarity, statistical variability, sensor response, and size of data set. Estimates of the errors associated with the factors, which are of general validity for the tidal bottom boundary layer, are presented and their differing relative importance for different turbulence parameters discussed. Methods of compensating for some of the sources of error are suggested. The six factors produce conflicting requirements for record length and digitization rate,

so a compromise must usually be made based on a tradeoff of the calculated errors associated with each factor. References (27 items).

Soulsby, R. L., and Dyer, K. R. 1981. "The Form of the Near-Bed Velocity Profile in a Tidally Accelerating Flow," Journal of Geophysical Research, 86(C9):8067-8074.

In a time-dependent turbulent flow, the near-bed velocity profile departs from the usual logarithmic profile. This is an effect of acceleration. An acceleration length, Λ, defined by the ratio of $u_*|u_*|$ to du_*/dt, is a measure of the thickness of a layer in which the acceleration effect is much smaller than the friction effect. The authors introduce another parameter, γ. $\gamma|u_*|$ may be interpreted as the average propagation velocity of eddies. To the first-order approximation, the velocity profile consists of two parts the usual logarithmic term and the modification, a term linearly proportional to the vertical distance from the bottom, $z/\gamma\Lambda$. Field measurements were carried out in bays in depth of 14 m and 17 m. Apparent values of von Karman's constant, κ, friction velocity, u_* and bed roughness length, z_0 obtained by the usual method from the field data should be corrected by taking the effect of $z/\gamma\Lambda$ into consideration. It is found that both u_* and z_0 are underestimated (overestimated) in an accelerating (decelerating) current. The value of κ decreases slightly with increasing boundary-layer-thickness-to-roughness-length ratio.

Spaulding, M. L. "A Vertically Averaged Circulation Model Using Boundary-Fitted Coordinates." (See complete entry in Section VI.)

Stacey, M. W. 1984. "The Interaction of Tides with the Sill of a Tidally Energetic Inlet," Journal of Physical Oceanography, 14(6):1105-1117.

The interaction of the tides with the sill of a tidally energetic inlet, Observatory Inlet, British Columbia, is studied. Because of temporal variations in the stratification of the inlet, a substantial seasonal variation is observed in the power withdrawn from the barotropic tide. Vigorous, nonlinear, internal motions occur in the region of the sill, but most of the withdrawn tidal power is fed into a progressive, linear internal tide. The first two modes, which contain almost all of the energy, respond very differently to changes in stratification. The energy flux of the first mode is insensitive to changes in surface stratification but increases dramatically as a result of deep water renewal. The energy flux of the second mode exhibits the reverse behavior, being insensitive to the occurrence of

deep water renewal but being a strong
positive function of the surface strat-
ification. Even though the inlet has a
distinct surface layer in summer and ap-
pears to be a two-layer system, the second
mode contains almost as much power as the
first, a characteristic not indicative of
simple two-layer flows. The nonlinear
sill processes induce a significant baro-
clinic flow at the beat frequency of the
M_2 and S_2 tides. This flow is most vigor-
ous near the surface of the inlet where it
is greater in magnitude than the M_2 baro-
tropic current. References (9 items).

Stark, K. P. "Simulation and Probabilities
of Tide and Cyclonic Storm Surges." (See
complete entry in Section VI.)

Stephens, H. S., and Stapleton, C. A., ed.
1981. Papers Presented at the Second In-
ternational Symposium on Wave and Tidal
Energy, September 23-25, 1981, Cambridge,
England, BHRA Fluid Engineering, Cran-
field, Bedford, England.

The conference includes sessions on wave
power, tidal power, air turbines, and bar-
rages with case studies. References are
included at the end of each paper.

Sternberg, R. W., et al. "Aquatic Disposal
Field Investigations, Columbia River Dis-
posal Site, Oregon; Appendix A: Investi-
gations of the Hydraulic Regime and Physi-
cal Nature of Bottom Sedimentation." (See
complete entry in Section V.)

Stigebrandt, A. 1981. "A Mechanism Govern-
ing the Estuarine Circulation in Deep,
Strongly Stratified Fjords," Estuarine,
Coastal and Shelf Science, 13(2):197-211.

The estuarine circulation in deep,
strongly stratified fjords is discussed.
It is argued that a two-layer description
of the stratification in the fjord is cor-
rect in very wide fjords (wide compared to
the width of the mouth) and possibly also
in narrow fjords with high runoff and/or
weak mixing. A theory for the thickness
and the salinity of the brackish layer in
a wide fjord was earlier developed by the
present author (and published in Swedish,
1975) and it is presented here. Among
other findings in that theory we may men-
tion that the thickness of the brackish
layer is primarily determined by the in-
ternal hydraulic control for high specific
runoff (runoff/unit horizontal surface
area of the fjord) and weak mixing. In
the other extreme, with low specific run-
off and strong mixing, the thickness of
the brackish layer is found to be propor-
tional to the Monin-Obukhov length. The
circulation in not very wide fjords is
also discussed. It is found that recircu-
lation in the brackish layer may be ex-
pected whereby a two-layer description of
the flow field breaks down at least

locally. A critical Rayleigh number that
seems to control the recirculation of
brackish water within the fjord is found.
A theory for the density difference be-
tween the mouth and the head in the brack-
ish layer in the fjord is developed from
the critical Rayleigh number condition.
It is found that this density difference
normally is proportional to the density
difference between the brackish water at
the mouth and the underlying seawater pro-
vided that the river runoff is not too
heavy and/or the mixing is not too weak.
This prediction is confirmed by extensive
measurements from the Nordfjord. Refer-
ences (16 items).

Stigebrandt, A. 1980. "A Mechanism that
Regulates the Mean Longitudinal Density
Gradient in the Brackish Layer in Fjords
with Topographical Control at Their
Mouths," Proceedings, Second International
Symposium on Stratified Flows, The Norwe-
gian Institute of Technology, Trondheim,
24-27 June 1980, Torkild Carstens and
Thomas McClimans, ed., 1:105-117.

The estuarine circulation in deep fjords
is discussed. It is argued that a two-
layer description of the stratification in
the fjord may be adequate in very wide
fjords (wide compared to the width of the
mouth) and, possibly, also in narrow
fjords with high runoff and/or weak mix-
ing. The circulation in narrow fjords
with lower runoff and/or stronger mixing
is discussed. It is found that recircula-
tion in the brackish layer may be expected
whereby a two-layer description of the
flow becomes incorrect at least locally.
A hydraulic theory for the density differ-
ence between the mouth and the head in the
brackish layer is developed. This density
difference is found to be proportional to
the density difference between the brack-
ish water at the mouth and the underlying
seawater. This prediction is very nicely
confirmed by extensive measurements from
the Nordfjord. References (9 items).

Stigebrandt, A. 1980. "Some Aspects of
Tidal Interaction with Fjord Constric-
tions," Estuarine and Coastal Marine Sci-
ence, 11(2):151-166.

Tidal interaction with fjord constrictions
is discussed. Two typical cases are thor-
oughly analyzed. The first is the so-
called tidal choking problem where the ef-
fect of vertical stratification is insig-
nificant. In the second case, the influ-
ence of vertical stratification is crucial
and the forcing barotropic tide generates
internal waves at the constriction (a sill
in this case). Some theoretical gaps in
the field of tidal interaction with fjord
constrictions are filled. First, a theory
for tidal choking in a fjord with fresh-
water runoff is presented. A table is
given which can be used for a quick deter-
mination of tidal choking effects in

almost any fjord. Second, a simple theory for internal wave generation by tides in a linearly stratified fjord is developed. The predictions are compared with measurements from the Herdlafjord (from Fjeldstad) with encouraging results. References (18 items).

Suga, K. "Field Phenomena of Salt-Wedge and Features of Internal Vortex." (See complete entry in Section III.)

Sündermann, J., and Elahi, K. Z. "Constructional Effects on the Dynamical Processes in a Tidal Inlet." (See complete entry in Section VI.)

Sündermann, J., and Holz, K.-P., ed. 1980. Mathematical Modelling of Estuarine Physics, Lecture Notes on Coastal and Estuarine Studies, Vol. 1, Springer-Verlag, New York.

Mathematical Modelling of Estuarine Physics is the first volume in the new series Lecture Notes on Coastal and Estuarine Studies. This volume was derived from contributions made at the Symposium on Mathematical Modelling of Estuarine Physics held at Hamburg, August 1978. Contents: "Basic Hydrodynamics and Thermodynamics," by W. Krauss, References (8 items); "Mathematical Modelling of Turbulence in Estuaries," by W. Rodi, References (18 items); "Fundamental Principles for Numerical Modelling," by M. B. Abbott, References (2 items); "Application of Finite-Difference Methods to Estuary Problems," by C. B. Vreugdenhil, References (15 items); "Finite Elements, A Flexible Tool for Modelling Estuarine Processes," by K.-P. Holz, References (13 items); "Mathematical Modelling of Fluid Flow Using the Boundary Element Method," by C. A. Brebbia and L. C. Wrobel, References (7 items); "Spectral Method for the Numerical Solution of Three-Dimensional Hydrodynamic Equations for Tides and Surges," by N. S. Heaps, References (11 items); "On the Formation of Salt Wedges in Estuaries," by E. Maier-Reimer, References (9 items); "On Currents in the German Bight," by J. Backhaus, References (5 items); "Tide-Induced Residual Flow," by J. van de Kreeke, References (10 items); "Simulation of Tidal River Dynamics," by K.-P. Holz, References (6 items); "Analysis of Tide and Current Meter Data for Model Verification," References (5 items); "Mathematical Modelling of Tidal Flats: A Few Remarks," by H. Holsters, References (7 items); "On Storm Surge Phenomena," by M. Laska, References (25 items); "Meterological Problems Associated with Numerical Storm Surge Prediction," by E. Roeckner, References (6 items); "A Coastal Ocean Numerical Model," by A. F. Blumbers and G. L. Mellor, References (15 items); "Modelling

and Verification of Circulation in an Arctic Barrier Island Lagoon System - An Ecosystem Process Study," by J. B. Matthews, Reference (1 item); "Salinity Intrusion Models," by K. Fischer, Reference (12 items); "A Point of View: Physical Processes on the Continental Shelf and Their Implications for Numerical Circulation Models," by C. N. K. Mooers; "Observations of Continental Shelf Circulations and Their Relation to Model Verification and Application," by B. Magnell; "Mathematical Models of Sediment Transport in Canalised Estuaries," by J. G. Rodger, References (9 items); "Numerical Modelling of Sediment Transport in Coastal Waters," by J. Sündermann and W. Puls, References (11 items).

Sündermann, J., Vollmers, H., and Berndt, D. 1978. "Protection Against Storm Surges in a Tidal River," Proceedings, International Conference on Water Resources Engineering, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:465-476.

Due to its geographical position, the German North Sea coast is often afflicted by heavy storm surges. This is true above all for the Elbe River, on which the main German port of Hamburg is situated. In the flood disaster of 1962, more than 300 people were killed. In the following years the dike line was shortened by damming up lateral tidal flats. However, the extremely high storm surges of 1976 have given rise to the assumption that the damming up has also a negative consequence: a higher rising and a faster propagation of the flood wave in the narrowed cross-section area. Therefore, a study program is being carried out to examine the relation between lateral geometrical and hydrodynamical changes in a tidal river, and also in view of further constructions. The study is performed by two models: a mathematical and a hydraulic one. References (4 items).

Sündermann, J., Vollmers, H., and Puls, W. "The Influence of Dune and Flow Parameters on the Friction Factor." (See complete entry in Section VI.)

Svasek, J. N., and Versteegh, J. "Mathematical Model for Quantitative Computations of Morphological Changes Caused by Man-Made Structures Along Coasts and in Tidal Estuaries." (See complete entry in Section VI.)

Swakon, E. A., Jr., and Wang, J. D. "Modeling of Tide and Wind Induced Flow in South Biscayne Bay and Card Sound." (See complete entry in Section VI.)

Swenson, E. M., and Chuang, W.-S. "Tidal and Subtidal Water Volume Exchange in an Estuarine System." (See complete entry in Section VIII.

Swift, M. R. "Spatially Varying Turbulence Production in Tidal Channels." (See complete entry in Section VI.)

Swift, M. R., and Brown, W. S. "Distribution of Bottom Stress and Tidal Energy Dissipation in a Well-Mixed Estuary." (See complete entry in Section VIII.)

Therriault, J. C., Ladurantaye, R. de, and Ingram, R. G. "Particulate Matter Exchange Across a Fjord Sill." (See complete entry in Section II.)

Thimakorn, P., and Gupta, A. D. "Concentration of Suspended Clay in Tidal Estuary." (See complete entry in Section II.)

Thompson, R. O. R. Y. "Low-Pass Filters to Suppress Inertial and Tidal Frequencies." (See complete entry in Section VII.)

Timmerman, H. 1979. "Forecasting Meteorological Effects on Water Levels on a Routine Basis with a Numerical Model," Deutsche Hydrographische Zeitschrift, 32(5):190-203.

In this article the suitability of a numerical model for forecasting the meteorological effects on water levels at the five main Dutch gage stations is investigated. Mean values and standard deviations of differences between observed and forecast meteorological effects during high and low tide for different forecast periods were determined for the period 1 October 1977 to 1 April 1978, and compared with persistence, i.e., a previously observed setup. Since the skill of the model highly depends on its behavior under extreme conditions, a selection was made of those cases with a considerable meteorological effect (12 dm or more at Vlissingen, Hoek van Holland and Den Helder, 15 dm or more at Harlingen and Delfzijl); and this selection was studied as well. Examining the persistence, it turned out that the observed meteorological effect is also influenced by inaccuracies in the tidal values. The skill of the model appeared to be satisfactory, especially when used as a warning system 12 to 24 hours in advance. References (11 items).

Tocker, P. "Stop Father Thames Flooding." (See complete entry in Section V.)

Trawle, M. J. "Effects of Depth on Dredging Frequency; Report 2, Methods of Estuarine Shoaling Analysis." (See complete entry in Section V.)

Trump, C. L. "A Current-Induced Ekman Spiral in the St. Lawrence Estuary." (See complete entry in Section VIII.)

Tucci, C. E. M., and Chen, Y. H. "Unsteady Water Quality Model for River Network." (See complete entry in Section VI.)

Turner, K. A., and Durham, D. L. "Documentation of Wave-Height and Tidal Analysis Programs for Automated Data Acquisition and Control Systems." (See complete entry in Section VI.)

Uncles, R. J. "A Note on Tidal Asymmetry in the Severn Estuary." (See complete entry in Section VI.)

Uncles, R. J. 1984. "Hydrodynamics of the Bristol Channel," Marine Pollution Bulletin, 15(2):47-53.

This paper considers tidal and residual currents separately and uses these results to review what is known of the effects of tidal stress on the seabed and on vertical mixing followed by their effects on dispersion of salt and other solutes. References (40 items).

Uncles, R. J. "Residual Currents in the Severn Estuary and Their Effects on Dispersion." (See complete entry in Section VI.)

Uncles, R. J., and Jordan, M. B. "A One-Dimensional Representation of Residual Currents in the Severn Estuary and Associated Observations." (See complete entry in Section VI.)

Uncles, R. J., et al. "Salinity of Surface Water in a Partially-Mixed Estuary, and Its Dispersion at Low Run-off." (See complete entry in Section III.)

US Army Engineer Division, New England. "Long Island Sound, Thamesville Tidal-Flood Management Water Resources Study, Norwich, Connecticut." (See complete entry in Section V.)

Ünlüata, Ü. A., and Özsoy, E. 1977. "Tidal Jet Flows Near Inlets," Hydraulics in the Coastal Zone, Proceedings, 25th Annual Hydraulics Division Specialty Conference, Texas A&M University, College Station, Texas, August 10-12, 1977, ASCE, 90-98.

Turbulent jets issuing from tidal inlets during the ebb flows are analyzed, and the effects of bottom friction and one-dimensional depth variations are shown to change the jet behavior in a drastic way. Jets on a constant bottom with friction expand in an explosive manner. When the depth increases in the offshore direction, the expansion rate of the jet is greatly reduced. The analytical solutions are verified against field evidence and preliminary experiments. References (11 items).

Vallianos, L. "Barden Inlet, N.C.: A Case Study of Inlet Migration." (See complete entry in Section V.)

van de Kreeke, J., and Chiu, A. A. 1981. "Tide-Induced Residual Flow in Shallow Bays," Journal of Hydraulic Research, 19(3):231-249.

The generation of residual flow is considered. For the computation of the tidal flow, a space-staggered grid is used. This approximation is second order in space, and first order in time. Although it is reported that the finite difference formulation considerably influences the residual flow, alternative difference approximations are not studied. A major topic of the paper is the nature of the secondary boundary condition along boundaries. Taking the velocity component parallel to the boundary equal to zero leads to an inacceptable flow pattern. A zero normal derivative of this velocity component, or treatment by means of backward difference, performs considerably better. The residual flow is calculated by averaging the computed tidal flow over the tidal period. Good agreement with an analytical solution is found. The applications are restricted to problems with very simple geometry.

van de Ree, W. J., Voogt, J., and Leendertse, J. J. "A Tidal Survey for a Model of an Offshore Area." (See complete entry in Section VII.)

Vincent, C. L., and Corson, W. D. 1981. "Geometry of Tidal Inlets; Empirical Equations," Journal, Waterway, Port, Coastal and Ocean Division, ASCE, 107(WW1):1-9.

The geometry of tidal inlet ebb shoal, main channel, and cross section is investigated. Formulae interrelating depths, length, and area parameters show a high degree of coherence in inlet geometry, with the cross-sectional area of the inlet a fundamental parameter. References (3 items).

Vongvisessomjai, S., and Srikanthan, R. 1978. "The Regimen of Takuapa Tidal Channel," Proceedings, International Conference on Water Resources Engineering, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:277-295.

Outflow features resulting from the interaction of channel with ocean tide are of importance to engineering works to be undertaken on a channel whose inlet is characterized by sediment flow and tidal flow regimen. The Takuapa channel, located on the west coast of Southern Thailand, is a classic example of a channel experiencing both ocean tide and flows of river sediment as well as sediment derived from tin mining nearby. A comprehensive hydrodynamic and sediment survey was made in the channel and inlet. Analysis was then taken which involved a numerical model, based on the equations of unsteady flow in open channels for computation of the tidal currents at several sections in the channel. The model used an implicit finite difference scheme in its computation. Sediment deposition and erosion were then estimated in the channel at various points from the knowledge of current velocity and characteristics of sediment. The stability of the inlet was also examined by using the simple tidal prism-area relationship and the more fundamental tidal prism-littoral drift ratio. References (10 items).

Vreugdenhil, C. B. 1978. "Application of Finite-Difference Methods to Estuary Problems," Publication No. 209, Waterloopkindig Laboratorium, Delft Hydraulics Laboratory, Delft, The Netherlands. Paper also presented at the Symposium, Mathematical Modelling of Estuarine Physics, August 24-26, 1978, Hamburg, Germany.

Some basic issues must be considered when choosing numerical methods for the study of estuarine physics. Examples are given concerning wave propagation in hyperbolic systems, representation of flow patterns, parabolic systems and the treatment of boundaries, especially fixed walls. Some current research projects will be used to illustrate the above-mentioned subjects: (a) two-layer flow in two horizontal dimensions, to be used, for example, for salt intrusion in an estuary; (b) a vertical two-dimensional model of tidal flow in an estuary, which may or may not take into account density stratification; and (c) a vertical two-dimensional quasi-steady model of suspended sediment transport, to be used, for example, for the study of sedimentation of dredged trenches in a tidal region. References (15 items).

Wada, A., and Miyaike, Y. 1978. "Characteristics of Circulation in Bay Waters due to Wind Action," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2730-2745.

This report concerns investigations into the three-dimensional mechanism of flow motion in the seawater of Mikawa Bay for the purpose of elucidating the effect of wind, tidal current, and topographical features on oceanic environmental fluctuations among factors related to the diffusion process in the bay. On the assumption that dynamics of the bay water would be affected by the tidal currents and the flow caused by the wind, a numerical simulation analysis of the flow motion phenomenon in the bay water was conducted on

the basis of the meteorological and ocean-
ographical observation data collected at
the points in the investigated sea region,
so as to examine the circulation mechanism
of the bay water caused by the above-
mentioned factors. As the results of the
simulation analysis by the numerical
models, large-scale eddies caused by the
tidal reciprocating current as well as the
constant current as the tidal residual
current can be seen in the bay. Also, in
the winter when the distribution of atmo-
spheric pressure is stable, some circula-
tion currents are formed in the bay by the
wind-generating current. Accordingly, it
is considered that the formation of these
currents has a considerable effect on the
diffusion characteristics of substances in
the bay. References (3 items).

†Wadsworth, J. R., Jr. 1980. "Geomorphic
Characteristics of Tidal Drainage Networks
in the Duplin River System, Sapelo Island,
Georgia," Ph. D. Dissertation, University
of Georgia, Athens.

A highly detailed drainage map, prepared
from tide-controlled, color infrared ae-
rial photography, was used to study geo-
morphology of tidal drainage networks in
the Duplin River system, Sapelo Island,
Georgia. Four principal drainage types
were distinguished through intrasystemic
variation in drainage density and channel
reticulation: discrete, dense semidis-
crete, sparse semidiscrete, and reticu-
lated. In addition, five important anoma-
lous drainage types were recognized lo-
cally: pirated and underfit streams and
ponded, annular, and complex drainage.
Dense semidiscrete drainage undergoes
rapid headward erosion and network exten-
sion, and channels gradually become inter-
connected, forming reticulated drainage.
Low rates of general surficial sedimenta-
tion and rapid lateral migration promote
reticulated drainage through retention of
pirated channels. Relatively high rates
of storm-related sedimentation in the
seaward end of the Duplin yield locally
higher slopes and development of discrete
drainage. Infrequent tidal flooding and
high permeability characteristic of the
high marsh suben· ironment produce sparse
semidiscrete drainage. Although in gen-
eral the Duplin system is youthful, exten-
sive areas of reticulated drainage are in
equilibrium with the environment and are
not evolving. Testing of characteristic
fluvial geomorphic relationships against
data for discrete drainage in the Duplin
system reveals important differences be-
tween the two systems, largely resulting
from bidirectional flow, environmental
nonuniformity, and rapid episodic deposi-
tion in the discrete drainage zone.

Wadsworth, J. R., Jr. 1981. "Structural
Control of Drainage Morphology of Salt

Marshes on St. Catherine's Island,
Georgia," Technical Report 82-1, Depart-
ment of Geology, University of South
Florida, Tampa.

The purpose of this study was to identify
the effects of structural control exerted
by relict Holocene beach ridges on mor-
phology of tidal drainage networks on
St. Catherine's Island, Georgia. Like
many barrier islands on the Georgia coast,
St. Catherine's consists of a core of
Pleistocene material, surrounded by an
extensive series of Holocene salt marshes
and relict beach ridges. These marshes
are very dynamic sedimentary systems, and
have extensive and intricate drainage net-
works that are constantly changing through
processes of lateral migration, stream
capture, and channel blockage and fill.
The extent and manner in which these proc-
esses operate depend upon such regional
variables as tidal range, climate, and
sediment type, as well as upon many local
influences. Among the most significant
local influences affecting the development
of tidal drainage morphology is structural
control. Only when the effects of this
control have been evaluated is it possible
to interpret the true response of drainage
morphology to regional variables and to
make legitimate comparisons between the
tidal drainage morphologies of widely
separated localities. Effects of local
structural control on salt marsh drainage
networks on St. Catherine's Island were
studied using photogrammetric methods
along with field investigation and topo-
graphic analysis. Initial topographic
analysis was used to check the validity of
the photogrammetric approach, and to help
select morphologic variables for subse-
quent measurement. Aerial photography of
the study area was examined, and measure-
ments describing the morphology of several
tidal drainage networks were made. A
field investigation was used to check pho-
to identification of drainage features and
provided close-up observation of some spe-
cific control mechanisms. References
(22 items).

Walters, R. A. "Low-Frequency Variations
in Sea Level and Currents in South San
Francisco Bay." (See complete entry in
Section VIII.)

Walters, R. A., and Cheng, R. T. "A Two-
Dimensional Hydrodynamic Model of a Tidal
Estuary." (See complete entry in Sec-
tion VI.)

Walters, R. A., and Heston, C. "Removing
Tidal-Period Variations from Time-Series
Data Using Low-Pass Digital Filters."
(See complete entry in Section VIII.)

Walther, A. W. 1980. "Hydraulic Research
in the Oosterschelde Estuary." Proceed-
ings, Seventeenth Coastal Engineering

Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2360-2376.

In 1974 a major policy change was made to the Delta plan to close the Ooster- schelde (East Scheldt). For ecological reasons it was decided to replace the originally planned barrier dam with a storm surge barrier. This could be opened to allow normal tidal movement or closed during storm surges. Instead of complet- ing the dam in 1978, the new structure would be finished in 1985. The vertical tidal movement in the estuary would be reduced to about 80 percent of the orig- inal tidal range, while under storm surge conditions the storm surge barrier (with a cross-sectional area of about 15,000 sq m) could be closed, thus serving both ecology and safety at the same time. This new concept required a large number of new in- vestigations in coastal engineering and soil mechanical fields. This paper gives a general description of some of the hy- draulic investigations. References (7 items).

Walton, R., Granat, M. A., and Shubinski, R. P. "Calibrating the Chesapeake Bay Circulation Model?" (See complete entry in Section VI.)

Wang, Y.-H. "Satellite Applications on a Coastal Inlet Stability Study." (See com- plete entry in Section VII.)

Ward, G. H., Jr. "Pass Cavallo, Texas; Case Study of Tidal-Prism Capture." (See com- plete entry in Section V.)

Ward, L. G. "Hydrodynamics and Sediment Transport in a Salt Marsh Tidal Channel." (See complete entry in Section II.)

Weggel, J. R., Roberts, J., and Hagar, J. "Wave Action on the Savannah Tide Gates." (See complete entry in Section V.)

Welch, J. M., and Parker, B. B. 1979. "Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina," NOAA Technical Report No. 80, National Oceanic and Atmospheric Administration, Rockville, Md.

The results from the harmonic analysis of the data from tide and current stations in the lower Cape Fear River are presented in the form of tables, cotidal and corange charts, and charts illustrating the rela- tionships among various harmonic constitu- ents. Salinity and temperature data are presented in the form of contours of lon- gitudinal transects and time series sta- tions covering full tidal cycles. Instru- mentation, data products, and the various methods of analysis are described. The implications from the results of the various methods of analysis of the circulation and hydrodynamics of the lower Cape Fear River are discussed. A simple one-dimensional model is presented to help describe the tidal hydrodynamics of a long, narrow estuary. The nontidal rise and fall of the water surface of the river as a result of the meteorological forces of wind and barometric pressure are dis- cussed. National Ocean Survey historical data, a physical description of the area, and approximate values of transport through several cross sections are given. It has been concluded that the tidal wave in the Cape Fear River is close to being a pure damped progressive wave with a par- tial reflection in the narrowing channel around Wilmington, N.C. The considerable amount of dredging that has taken place in the past 100 years has resulted in signif- icant physical parameter changes. The flow regime in the Cape Fear River is the result of gravitational effects caused by salinity intrusion, freshwater riverflow, the river bathymetry, and channel struc- ture. Salinity data indicate that the river changes from being partially mixed vertically to well mixed vertically as one progresses up the river. References (19 items).

West, J. R., Knight, D. W., and Shiono, K. 1984. "A Note on Flow Structure in the Great Ouse Estuary," Estuarine, Coastal and Shelf Science, 19(3):271-290.

Field measurements of vertical profiles of velocity and salinity along with turbu- lence measurements have been used to exam- ine the effect of density gradients on the flow structure in the Great Ouse estuary. During the flood tide, shear and longitu- dinal density gradients cause well-mixed conditions in the lower part of the water column. In the upper part of the water column, secondary flow effects induced by transverse density gradients, and accel- eration effects can contribute to the for- mation of stable vertical density gra- dients. On the ebb tide, the vertical den- sity gradient appears to be the dominant factor which determines the structure of the flow. The velocity and shear stress data show the evidence of large-scale mo- tions which are consistent with the postu- lated flood and ebb flow structures. Ref- erences (21 items).

Whalin, R. W. "Los Angeles Harbor and Long Beach Harbor: Plan of Study." (See com- plete entry in Section VI.)

Whalin, R. W. "Los Angeles Harbor and Long Beach Harbor: Summary of Results and Future Plans." (See complete entry in Section VI.)

Wilkinson, D. L. "Periodic Flows from Tidal Inlets." (See complete entry in Sec- tion VI.)

Williamson, A. N. "Movement of Suspended Particles and Solute Concentrations with Inflow and Tidal Action." (See complete entry in Section VIII.)

Winterwerp, J. C. "Decomposition of the Mass Transport in Narrow Estuaries." (See complete entry in Section III.)

Wiseman, W. J., Jr. "Hypersaline Bottom Water: Peard Bay, Alaska." (See complete entry in Section III.)

Wong, K.-C. 1981. "Subtidal Volume Exchange and the Relationship to Atmospheric Forcing in Great South Bay, New York," Ph. D. Dissertation, Marine Sciences Research Center, State University of New York, Stony Brook.

Great South Bay is a very shallow bar-built estuary located on the south shore of Long Island, N.Y. The bay communicates with the adjacent shelf waters through a total of five inlets. Seasonal variations in both the intensity of volume exchange between the bay and the shelf at subtidal frequencies and the relation to local and nonlocal atmosphere forcing are examined through time series analysis of records of sea level, current, wind, and atmospheric pressure. Numerical simulations using a vertically integrated finite element model have provided a quantitative assessment of the characteristics of volume exchange processes at subtidal frequencies within the bay and the partitioning of the total volume flux among each of the inlets. Subtidal sea level fluctuations within the bay are strongly coupled to coastal sea level fluctuations at time scales longer than 3 days during both winter and summer. During the winter, coastal Ekman forcing induced by longshore wind stress is the most important mechanism for producing subtidal fluctuations in coastal sea level; the variance in sea level is confined to time scales longer than 3 days. The inverted barometer effect accounts for approximately 25 percent of the variance in coastal subtidal sea level in the winter, and it tends to counteract coastal Ekman effect at time scales longer than 5 days. During the summer, the wind stress is less stationary, and the response of coastal sea level to wind forcing is more complex. The inverted barometer effect accounts for approximately 30 percent of the variance in coastal sea level; it tends to counteract Ekman forcing at time scales between 3 and 7 days and reinforces Ekman forcing at time scales longer than 7 days. The intensity of subtidal sea level fluctuations is much higher in the winter than in the summer due primarily to the overall increase in the variance of wind stress during the winter. The intensity of the subtidal volume exchange between the bay and the shelf during the winter is higher than during the summer, especially at time scales between 2 and 10 days where the variance in total subtidal volume flux in winter is more than double of that in summer. References (38 items).

Wong, K.-C., and Wilson, R. E. 1979. "An Assessment of the Effects of Bathymetric Changes Associated with Sand and Gravel Mining on Tidal Circulation in the Lower Bay of New York Harbor," Special Report 18, Marine Sciences Research Center, State University of New York, Stony Brook.

Present sand and gravel mining operations within the Lower Bay of New York Harbor are restricted to the east bank of Ambrose Channel and to the vicinity of Chapel Hill North Channel because of the concern that mining in other areas might adversely affect water quality and shore erosion. As part of an evaluation of environmental effects associated with expanded sand and gravel mining, the authors have simulated numerically tidal circulation patterns and tidal elevations in Lower Bay for a number of altered bathymetries corresponding to hypothetical mining operations. Results suggest that tidal currents will decelerate over the mined region and accelerate outside of them, and that the tidal stream will be deflected towards the region. It is also clear that the mining near the mouth of the bay could increase tidal range along Staten Island substantially. References (6 items).

Wood, T. "Discrete-Time Modelling of Dispersion in Estuaries." (See complete entry in Section VI.)

Yakuwa, I., Takahashi, S., and Ohtani, M. "Behaviors of the Salt Wedge and the Salinity Distribution at Estuaries." (See complete entry in Section III.)

Yoshida, S. "Mixing Mechanisms of Density Current System at a River Mouth." (See complete entry in Section III.)

SECTION II. SEDIMENTATION

Sources, identification, transportation, deposition, flocculation, and physical and chemical properties of sediment found in tidal waterways. The upland river is excluded unless specifically concerned as a source and agent of transport of tidal sediment.

Aston, S. R., and Stanners, D. A. "Americium in Intertidal Sediments from the Coastal Environs of Windscale." (See complete entry in Section IV.)

Aston, S. R., and Stanners, D. A. "Gamma Emitting Fission Products in Surface Sediments of the Ravenglass Estuary." (See complete entry in Section IV.)

Aston, S. R., and Stanners, D. D. "The Transport to and Deposition of Americium in Intertidal Sediments of the Ravenglass Estuary and its Relationship to Plutonium." (See complete entry in Section IV.)

Aston, S. R., et al. "Plutonium Occurrence and Phase Distribution in Sediments of the Wyre Estuary, Northwest England." (See complete entry in Section IV.)

Baliga, B. R., and Hudspeth, R. T. "Evaluation of Sand Waves in an Estuary." (See complete entry in Section IV.)

Bartholdy, J. "Transport of Suspended Matter in a Bar-Built Danish Estuary." (See complete entry in Section VI.)

Bohlen, W. F. "Factors Governing the Distribution of Dredge-Resuspended Sediments." (See complete entry in Section VIII.)

Bohlen, W. F., and Marine Sciences Department, University of Connecticut. 1980. "A Comparison Between Dredge Induced Sediment Resuspension and That Produced by Natural Storm Events," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, II:1700-1707.

Field observations indicate that the effect of dredge-induced resuspension on sediment transport within small estuaries is generally negligible in comparison to the transport induced by natural storm events. Data obtained in the Thames River, near New London, Connecticut, show dredge-induced resuspension to be essentially a near field phenomenon. The resultant plume of material increases total suspended load in the river by approximately 25 percent but extends over less than 2.5 percent of the total estuarine area. In contrast, storms are observed to increase total suspended load by a factor of three, influencing concentration levels throughout the estuary. These factors, in combination with the lower frequency of dredging vis-à-vis significant storm events, appear to effectively limit the influence of dredge-induced resuspension. References (4 items).

Bottin, R. R., Jr., and Earickson, J. A. "Buhne Point, Humboldt Bay, California, Design for the Prevention of Shoreline Erosion; Hydraulic and Numerical Model Investigations." (See complete entry in Section VI.)

Boyden, C. R., Aston, S. R., and Thornton, I. 1979. "Tidal and Seasonal Variations of Trace Elements in Two Cornish Estuaries," Estuarine and Coastal Marine Science, 9(3):303-317.

Tidal and seasonal changes in trace element concentrations have been studied in solution, suspended particulates, and bottom sediments at locations in two Cornish estuaries. Results show that considerable differences in concentrations and behavior of trace elements occur on a tidal and seasonal basis. These differences have been related to the influences of freshwater input from mineralized catchments and discussed in terms of mixing of runoff with saline waters during diurnal and annual cycles. References (13 items).

Brazier, A., and Strachan, W. V. "Swansea Channel--A Study of Waterways Management." (See complete entry in Section V.)

Callender, E., and Hammond, D. E. 1982. "Nutrient Exchange Across the Sediment-Water Interface in the Potomac River Estuary," Estuarine, Coastal and Shelf Science, 15(4):395-413.

The flux of ammonia, phosphate, silica and radon-222 from Potomac tidal river and estuary sediments is controlled by processes occurring at the sediment-water interface and within surficial sediment. Calculated diffusive fluxes range between 0.6 and 6.5 mmol m^{-2} day^{-1} for ammonia, 0.020 and 0.30 mmol m^{-2} day^{-1} for phosphate, and 1.3 and 3.8 mmol m^{-2} day^{-1} for silica. Measured in situ fluxes range between 1 and 21 mmol m^{-2} day^{-1} for ammonia, 0.1 and 2.0 mmol m^{-2} day^{-1} for phosphate, and 2 and 19 mmol m^{-2} day^{-1} for silica. The ratio of in situ fluxes to diffusive fluxes (flux enhancement) varied between 1.6 and 5.2 in the tidal river, between 2.0 and 20 in the transition zone, and from 1.3 to 5.1 in the lower estuary. The large flux enhancements from transition zone sediments are attributed to macrofaunal irrigation. Nutrient flux enhancements are correlated with radon flux enhancements, suggesting that fluxes may originate from a common region and that nutrients are regenerated within the upper 10-20 cm of the sediment column. The low fluxes of phosphate from tidal river sediments reflect the control benthic sediment exerts on phosphorus through sorption by sedimentary iron oxyhydroxides. In the tidal river, benthic fluxes of ammonia and phosphate equal one-half and one-third of the nutrient input of the Blue Plains sewage treatment plant. In the tidal Potomac River, benthic sediment regeneration

supplies a significant fraction of the nutrients utilized by primary producers in the water column during the summer months. References (66 items).

Coastal Sediments '77, Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Charleston, South Carolina, November 2-4, 1977, ASCE.

The functional design of structural and nonstructural solutions of shore protection and inlet stabilization is discussed. Among the issues covered are beach fill design; dredging; anticipated and unanticipated effects of coastal structures on adjacent shores; sediment transport under waves; coastal processes and inlets; design and effects of groins on beaches and channels; sand bypass systems at coastal inlets; onshore transport sediment; overwash hydraulics and sediment response; mathematical predictions of dredging quantities; effectiveness of beach deposit nourishment; effects of jetties; the role of wave reflection in coastal processes; low-cost shore protection; inlet design and offshore breakwaters; beach study techniques; and US Army Corps of Engineers data collection programs. References (811 items).

Colman, R. S. "The Modification of a Natural Drainage System and the Subsequent Effects on a Small Estuary and its Surrounding Beaches." (See complete entry in Section V.)

Connell, D. W., et al. "Effects of a Barrage on Flushing and Water Quality in the Fitzroy River Estuary, Queensland." (See complete entry in Section V.)

Connolly, J. P., Armstrong, N. E., and Miksad, R. W. "Adsorption of Hydrophobic Pollutants in Estuaries." (See complete entry in Section IV.)

Czerniak, M. T. 1976. "Engineering Concepts and Environmental Assessment for the Stabilization and Sand Bypassing of Moriches Inlet, New York," Tetra Tech, Inc., Pasadena, Calif.

This report examines the conditions at Moriches Inlet, New York. In recent years, the changing inlet conditions have resulted in the severe erosion of the barrier island and shoaling in some areas of the inlet. Unless action is taken to change conditions at Moriches Inlet, the ecological, economic and recreational resources dependent on the inlet will be jeopardized. The purpose of this study was to develop engineering concepts for the stabilization and sand bypassing of Moriches Inlet, and to provide a preliminary environmental impact assessment of these actions. The study shows that Moriches Inlet can be stabilized against

further rapid change with a minimum of physical alteration. Sand bypassing measures are feasible, but the plan must include provisions for trapping sand on both sides of the inlet. Both beneficial and nonbeneficial environmental impacts would result from these actions, but the resources provided by the inlet will be protected. References (47 items).

Dennis, W. A., Lanan, G. A., and Dalrymple, R. A. "Case Studies of Delaware's Tidal Inlets: Roosevelt and Indian River Inlets." (See complete entry in Section VI.)

DeWall, A. E., et al. 1984. "Inlet Processes at Eel Pond, Falmouth, Massachusetts," Miscellaneous Paper CERC-84-9, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report describes a combined office and field study designed to define the causes of a shoaling problem at the entrance to a small craft harbor. The office study consisted of an evaluation of the history of inlet development and an analysis of available wind, current, and wave data. In addition, a one-dimensional numerical model was used to predict stability with varying inlet geometry and the addition of stabilizing structures. Field measurements used in model calibration included water level, current velocity, beach and nearshore sediment samples, bathymetric surveys, and bed form measurements. Inlet hydraulics were found to be dominated by flood tidal flow through Eel Pond into the adjoining Waquoit Bay, causing the pond to act as a sediment sink. Several modifications to the inlet geometry are proposed for reducing inlet shoaling rates. References (32 items).

Drapeau, G., and Fortin, G. 1978. "Tidal Sedimentation in Gros-Cacouna Harbor," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1986-2000.

The harbor of Gros-Cacouna or the south shore of the St. Lawrence Estuary has been silting at the rate of 31 cm year since it was dredged at the depth of 14 m in 1968. Measurements of temperature, salinity, turbidity, current speed, and direction were carried out as well as bottom sampling and reflection seismic profiling. A model of suspended sediment transport combines the tidal volumes and the current profiles at the harbor entrance. During a period of high turbidity (spring) in the St. Lawrence Estuary, 54.2 tons of suspended sediments entered the harbor during the flood phase, while 41.1 tons were carried out during the ebb phase of a semi-diurnal tide. Nearly 13.1 tons of sediments in the harbor. The transfer of the sediment is thus influenced that the deposition of the

suspended sediment load settles in the harbor during one tidal cycle. In September, the turbidity is low in the estuary and the suspended sediment budget in the harbor is four times smaller but the ratio of deposited sediments versus the total quantity of sediments transported in suspension is the same. References (11 items).

Druery, B. M. "Estuarine Response to Dredging in the Tweed River, Australia." (See complete entry in Section V.)

Druery, B. M., and Nielsen, A. F. 1980. "Mechanisms Operating at a Jettied River Entrance," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2607-2626.

Between October 1976 and July 1977, a northern rubble mound jetty was constructed at the mouth of the Hastings River, transforming the entrance from a single- to a double-jettied system. Prior to the jetty construction, the entrance was characterized by the presence of a substantial swash bar (alternatively called an ebb delta marginal shoal), which was a continuous feature over 100 years of hydrographic survey records. However, construction of the northern jetty triggered an unprecedented onshore movement of the swash bar. This movement was well documented by a field monitoring program incorporating hydrosurveys, aerial photographs, tidal gagings, sediment sampling, float tracking, and nearby wave rider buoy information. A semiquantitative model was developed to aid understanding and quantification of the macrosedimentary processes associated with this phenomenon. The model demonstrated that the sudden reduction of the swash bar was due to the disruption of a circulation of sand which had previously aided the dynamic stability of the bar. The quantitative predictions of the model agreed well with subsequent entrance behavior. The philosophical development of the model and its findings are discussed in detail. In the literature there is a general lack of attempts to quantify the sediment transport relationships between the gross morphologic features of tidal entrances. This paper presents a methodology for assessing the sedimentary process at tidal entrances. References (9 items).

Dyer, K. R. 1984. "Sedimentation Processes in the Bristol Channel/Severn Estuary," Marine Pollution Bulletin, 15(2):53-57.

In view of the small subtidal prism in the estuary above the Holms, it is possible that the system is more or less in balance and that any further sediment input would be deposited outside the Holms. The major sediment supply seems to be of

fine-grained material from the rivers, but because of the very high tidal energy, the existing sediments are continually being reworked and redistributed. Any major alteration of the topography or the tidal regime would disrupt this regime. Because of the large quantity of fine sediment in motion and its affinity for pollutants, it is important to understand the processes by which the high concentrations settle, erode and mix. References (29 items).

Elsinger, R. J., and Moore, W. D. "^{226}Ra and ^{228}Ra in the Mixing Zones of the Pee Dee River-Winyah Bay, Yangtze River and Delaware Bay Estuaries." (See complete entry in Section IV.)

Escoffier, F. F. "Hydraulics and Stability of Tidal Inlets." (See complete entry in Section I.)

Everts, C. H. 1980. "A Method to Predict the Stable Geometry of a Channel Connecting an Enclosed Harbor and Navigable Waters," Technical Paper 80-6, US Army Coastal Engineering Research Center, Ft. Belvoir, Va.

A desirable design criterion for an enclosed harbor is that the channel connecting it with navigable waters be self-maintaining. This condition will prevail where sediment movement is negligible, or in the case of moving sediment, where tidal or river discharge is sufficient to maintain acceptable channel dimensions. A method to predict the stable configuration of such a channel is presented in this paper. A relationship between stable channel cross-sectional area, cross-sectional shape, and bottom elevation of the channel and the water discharge through the channel is determined using the geometric characteristics of nearby natural channels and the hydraulic regimes that sustain those channels. References (8 items).

Everts, C. H. "Design of Enclosed Harbors to Reduce Sedimentation." (See complete entry in Section V.)

Falconer, R. A. "Mathematical Model Study of Mass Transport in Harbours." (See complete entry in Section VI.)

Ferentinos, G., and Collins, M. 1980. "Effects of Shoreline Irregularities on a Rectilinear Tidal Current and Their Significance in Sedimentation Processes," Journal of Sedimentary Petrology, 50(4):1081-1094.

Detailed tidal current information collected in the embayments along the coastline of the central northern Bristol Channel, using both Eulerian and Lagrangian techniques, has demonstrated the existence

of tidally induced eddies. These eddies are considered by the authors to be the result of flow separation downstream of the headlands, due to the interaction between the coastal irregularities and the offshore rectilinear tidal current system. Supplementary tidal current observations, adjacent to the coastal discontinuities in the area under investigation, are indicative of the formation of similar eddies. The tidally induced eddies along the northern Bristol Channel coastline are related to the formation of either mud or sand (sand ridge) deposits, which occur along the coastal boundary. The eddies lead to the deposition of fine-grained material at their center, due to a reduction in the magnitude of the current speed, bed shear stress, and turbulence. The mud deposits are without any relief; therefore, the eddies are the sole mechanism responsible for their formation and maintenance. In contrast, the presence of appreciable relief in the sand deposits (sand ridges) introduces secondary flows and brings other hydraulic mechanisms into play. The fact that the main axes of the sand ridges are subparallel to the tidal flow suggests that Smith's and Huthnance's mechanisms are also operational and therefore enhancing the maintenance and evolution of the sand ridges. Sand ridges in the English Channel which occur off promontories are also related to tidally induced eddies. References (40 items).

FitzGerald, D. M., Fico, C., and Hayes, M. O. 1979. "Effects of the Charleston Harbor, S.C., Jetty Construction on Local Accretion and Erosion," Coastal Structures 79: A Specialty Conference on the Design Construction, Maintenance and Performance of Port and Coastal Structures, March 14-16, 1979, Alexandria, Va., ASCE, II:641-661.

The stabilization of a tidal inlet interrupts the natural sediment transport patterns of the ebb-tidal delta and adjacent beaches. The resulting erosional-depositional changes to both onshore and offshore areas are caused by an adjustment of this system to new hydraulic and wave energy conditions. The morphological changes which have occurred due to jetty construction at Charleston Harbor, S. C., have been caused by the redirection of the main ebb-channel; the confinement of the ebb-tidal currents to the jettied channel causing the transport of sand to deeper waters; the prevention of natural sediment bypassing mechanisms; and a redistribution of wave energy and tidal currents. The ebb-tidal delta and adjacent beaches have responded to these conditions by adding sediment to the updrift barrier and offshore region, accelerating the erosion of the downdrift barrier and redistributing the ebb-tidal delta sediments to the old

channel location and to the barrier island systems to the south. A substantial amount of sediment was deposited in the offshore region downdrift of jetties between 1921 and 1965. The source of this accretion is believed to be sand that has been transported seaward through a secondary ebb-channel located next to the jettied channel. References (30 items).

Foster, D. N., McGrath, B. L., and Bremner, W. "Rosslyn Bay Breakwater, Queensland, Australia." (See complete entry in Section VI.)

Gatto, L. W. "Estuarine Processes and Intertidal Habitats in Grays Harbor, Washington; A Demonstration of Remote Sensing Techniques." (See complete entry in Section I.)

Gibbs, R. J. 1977. "Suspended Sediment Transport and the Turbidity Maximum," Estuaries, Geophysics, and the Environment, National Academy of Sciences, Washington, D.C., 104-109.

The suspended materials that are discharged by rivers into estuaries and oceans transport many pollutants and are the natural material that fills our channels and harbors. From the biological and health viewpoint, the suspended materials are seen as the natural food of the filter feeding organisms; therefore, pollutants can adversely affect many varieties of seafood. References (18 items).

Giese, E. H. T. "Use of an Estuary Mobile Bed Model to Investigate Natural Sedimentation Processes." (See complete entry in Section V.)

Gordon, D. C., and Longhurst, A. R. "The Environmental Aspects of a Tidal Power Project in the Upper Reaches of the Bay of Fundy." (See complete entry in Section V.)

Gourlay, M. R., and Hacker, J. L. 1978. "The Interaction Between Fluvial and Tidal Processes in the Pioneer River Estuary," Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:34-38.

Sedimentological analyses of riverbed samples together with data obtained from surveys and aerial photographs have confirmed that the Pioneer River is actively contributing sediment to the estuary area near Mackay. The sand supplied by the river is redistributed within the estuary by the tidal currents while the gravel remains as an armor layer only disturbed in flood time. Significant changes in the location of both the river mouth and the foreshore south of it are the result of

interaction between flood flows and new
beach and dune systems constructed by
waves and wind from sediments supplied by
the river. Mangrove colonization is an
essential part of the consequent natural
reclamation process. These natural pro-
cesses in the Pioneer estuary have been
modified by engineering works such as
training walls, bridges, and their associ-
ated embankments. References (5 items).

Greer, M. N., and Madsen, O. S. 1978.
"Longshore Sediment Transport Data: A
Review," Proceedings, Sixteenth Coastal
Engineering Conference, August 27-
September 3, 1978, Hamburg, Germany, ASCE,
II:1563-1576.

Siltation rates anticipated at harbor
entrances, in navigation channels, and at
inlet structures as well as possible ad-
verse effects caused by these and other
coastal engineering constructions are of-
ten assessed based on considerations of
longshore sediment transport rates. The
ability to predict the longshore sediment
transport rate is consequently of consid-
erable importance in many coastal engi-
neering problems. The engineering need
for an ability to predict longshore sedi-
ment transport rates is evidenced by the
fact that the development of empirical
relationships preceded, by decades, any
attempts at rigorous analyses of the me-
chanics of sediment transport processes in
the surf zone. The review emphasizes a
critical evaluation of the different meth-
ods used for the determination of the
longshore sediment transport rate. The
assumptions underlying the use of a par-
ticular method are discussed and the
degree to which these assumptions are
violated or not is investigated from the
reported data. References (7 items).

Hale, J. 1979. "Emergency Erosion Pro-
tection and Contingency Planning for Los
Angeles County," Shore and Beach,
47(2):31-34.

After considerable wave damage to shore-
line property in the winter of 1978, the
County of Los Angeles drew up an erosion
contingency plan for protection assistance
for private property owners. The program
aims to make shoreline statistics avail-
able to provide engineers with information
about how the beach characteristics vary
between seasonal storms. The statistics
include the prediction of tides, the moni-
toring of waves, and the compilation of
beach profiles (showing both the maximum
and minimum size). References (4 items).

Hales, L. Z. "Erosion Control of Scour
During Construction; Report 8, Summary
Report." (See complete entry in Sec-
tion V.)

Hawley, N. "Intertidal Sedimentary Struc-
tures on Macrotidal Beaches." (See com-
plete entry in Section I.)

Hayes, M. O., Kana, T. W., and Barwis, J. H.
"Soft Designs for Coastal Protection at
Seabrook Island, S.C." (See complete
entry in Section VIII.)

Heathershaw, A. D., Carr, A. P., and
Blackley, M. W. L. 1981. "Swansea Bay
(SKER) Project, Topic Report 8; Coastal
Erosion and Nearshore Sedimentation Pro-
cesses," Report No. 118, Institute of
Oceanographic Sciences, Crossway, U.K.
(Unpublished Manuscript).

This is the final report in a series de-
scribing the results of a research project
to study the sedimentation regime in Swan-
sea Bay in relation to the erosion of sand
on the foreshore. Previous reports have
treated various aspects in detail; this
one attempts to give a broad overview and
to draw conclusions of wider relevance.
Thus the report falls into two parts, the
first dealing with purely regional aspects
of the sediment circulation pattern and
budget in Swansea Bay, and the second con-
cerned with those aspects of the study
which are of more general scientific in-
terest and relevance to the coastal engi-
neering community and which have a bearing
on coastal erosion processes in general.
References (68 items).

Heathershaw, A. D., and Hammond, F. D. C.
"Swansea Bay (SKER) Project, Topic Report
4; Tidal Currents: Observed Tidal and
Residual Circulations and Their Response
to Meteorological Conditions." (See com-
plete entry in Section I.)

Heathershaw, A. D., and Hammond, F. D. C.
1979. "Swansea Bay (SKER) Project, Topic
Report 6; Offshore Sediment Movement and
Its Relation to Observed Tidal Current and
Wave Data," Report No. 93, Institute of
Oceanographic Sciences, Crossway, U.K.
(Unpublished Manuscript).

Measurements of sediment transport rates
and circulation patterns in Swansea Bay
are given. The relative magnitudes of
suspended and bed-load transport are de-
termined with the aim of identifying the
processes involved in this transport.
References (54 items).

Helwick, S. J., and Bryant, W. R. 1977.
"Geology and Geotechnical Characteristics
of Sediments in East Bay Area, Mississippi
Delta," Marine Geotechnology, 2:161-175.

Deltaic sedimentation has produced an ac-
cumulation of clay and silt with a maximum
thickness of 90 m in East Bay area. Sedi-
ments in the upper 50 m grade from inter-
bedded sand, silt, and clay near South
Pass and Southwest Pass to predominantly

clay in the central part of the area. The variation in the types of sediments and rates of deposition greatly affected the engineering properties of these deposits. Sediments from boreholes in the central part of the area have shear strengths of less than 10 kPa to a depth of at least 50 m. Near the distributaries, shear strength increases with depth; values as high as 43 kPa were measured in sediments in the upper 50 m. These sediments are generally stronger and coarser, and have a lower water content and liquid limit than do sediments at comparable depths in the central part of the area. References (8 items).

Higgs, K., Treloar, P. D., and Lawson, N. V. "Comparison of Results from Physical and Mathematical Tidal Flow Models with Proto- type Data in Botany Bay." (See complete entry in Section V.)

Hodgson, R. T., Pettibone, B., and Sullivan, S. M. 1978. "Siltation Study of Humboldt Bay Marina, California," Shore and Beach, 46(1):21-27.

The salinity of the studied area is nei- ther vertically mixed nor highly strati- fied, implying that it is a partially mixed estuary. The predominant water mo- tion in the area is tidal. Flow predomi- nance calculations show (a) the zone of no net movement approached the bottom at the furthest station upstream, an area which does appear to be subject to rapid sedi- mentation; and (b) a flood channel exists between Daby Island and the mainland. The sediment which reaches Eureka Channel from Eureka Slough may be transported into Arcata Bay through this flood channel. Therefore, the sedimentation rate of Eureka Channel should be relatively low. The continual maintenance of depth by Eureka Channel, as compared to Eureka Slough, without the influence of dredging supports this hypothesis. References (13 items).

Hubbard, D. K., Oertel, G., and Nummedal, D. "The Role of Waves and Tidal Currents in the Development of Tidal-Inlet Sedimentary Structures and Sand Body Geometry: Exam- ples from North Carolina, South Carolina, and Georgia." (See complete entry in Section I.)

Hurtt, A. C., and Quinn, J. G. 1979. "Dis- tribution of Hydrocarbons in Narragansett Bay Sediment Cores," Environmental Science & Technology, 13(7):829-836.

Twenty cores were analyzed to provide data on the distribution of sedimentary hydro- carbons from various areas of Narragansett Bay. There was a decrease in surface (0-5 cm) sediment hydrocarbons from the Providence River to the mouth of the bay and the concentrations also decreased with depth in the cores, generally levelling off at 20-25 cm. This depth is probably related to increased petroleum utilization at the end of the 19th century. Several areas of the bay showed increasing hydro- carbons with depth, but the exact cause of this phenomenon could not be deter- mined. The results of this study indicate that the major source of anthropogenic hydrocarbons in bay sediments is the Providence River. These compounds are introduced into the bay via tidal trans- port of suspended material from the river and undergo gradual sedimentation through- out the estuary. References (27 items).

Indlekofer, H. "On Numerical Stability of One-Dimensional Sediment Transport Models for Unsteady and Tidal Flows." (See com- plete entry in Section VI.)

Jain, S. C. "Movable-Bed Tidal Inlet Model." (See complete entry in Section VI.)

Jenkins, S. A., Inman, D. L., and Bailard, J. A. "Opening and Maintaining Tidal Lagoons & Estuaries." (See complete entry in Section VI.)

Jones, G. 1981. "Effects of Dredging and Reclamation on the Sediments of Botany Bay," Australian Journal of Marine and Freshwater Research, 32(3):369-377.

Bottom sediments in Botany Bay were sur- veyed and analyzed for particle size using a wet-sieving volumetric determination. Sediments are predominantly clean sands, although substantial changes in sediment type have occurred in the northern region of the bay since 1968. Large areas which were formerly clean sand now contain sig- nificant amounts of mud. This increase in fine sediments is particularly marked in the dredged areas protected by the Port Botany revetment and the Kingsford-Smith Airport runway extension. These changes have not been the result of exposure by dredging of silt and clay lenses within the underlying sediments, but have prob- ably been caused by the combined effects of deposition of fine material discharged during dredging and reclamation and in- creased deposition of fluvial suspended matter due to changes in tidal circulation following the development of port and air- port facilities. Sediments in the Port Botany harbor area are expected to become progressively more muddy. Water turbidity in turn may increase as a result of resus- pension of fine material by shipping move- ments. References (8 items).

Kai, Y. 1980. "Some Aspects of Coastal Engineering Research Works in China," Pro- ceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, II:1735-174'.

A brief description is presented of research on the sedimentation of harbors along silty and sandy coasts as well as research on estuary regulation and wave protection.

Kawahara, M. "Periodic Finite Elements in Two-Layer Tidal Flow." (See complete entry in Section I.)

Kelley, J. T. 1983. "Composition and Origin of the Inorganic Fraction of Southern New Jersey Coastal Mud Deposits," Geological Society of America Bulletin, 94(6):689-699.

The decreasing areal extent of Cape May Peninsula lagoons in historical times and surfaceward-increasing concentrations of anthropogenically released heavy metals in lagoonal sediment suggest that the Atlantic coastal marshes of southern New Jersey are rapidly accumulating fine-grained sediment. Potential sources of sediment to this area include Pleistocene mud deposits on the continental shelf, fine sediment moving from north to south with the longshore drift, and Delaware Bay mud escaping the estuary on ebb tides. To determine the origin of the modern coastal muds of south New Jersey, sediment from each source was compared with suspended sediment entering Cape May Peninsula tidal inlets on flood tides. Although suspended sediment was considerably finer grained than material from other locations, the mud fraction of all sediment samples possessed a primary mode of ~0.5 μm and a secondary mode of ~8 μm. All samples exhibited great variation in mineralogy with grain size but possessed similar relative abundances of minerals within fractionated size classes. In general, feldspar dominated the silt fraction, with increasing quantities of illite, chlorite, and montmorillonite found in progressively finer sizes. On the basis of mineralogy, bottom sediment from northeast Delaware Bay, the Atlantic inner continental shelf, and mud from New Jersey beaches cannot be differentiated and ultimately may be derived from the same material--the eroding, Pleistocene-age Cape May Formation. The mineralogy of suspended sediment exiting Delaware Bay on ebb tides and entering Cape May Peninsula inlets on flood tides is identical, and it differs from bottom sediment by possessing slightly more feldspar and biotite and less chlorite. A consideration of the water circulation around Cape May Peninsula and evaluation of all available Landsat imagery of the area suggest that resuspension of northeast Delaware Bay bottom sediment, augmented by contributions from the Delaware River, provides most of the fine-grained sediment to the Atlantic coastal marshes of Cape May Peninsula. References (40 items).

Kerssens, P. J. M., Prins, A., and Van Rijn, L. C. "Model for Suspended Sediment Transport." (See complete entry in Section VI.)

Kerssens, P. J. M., Van Rijn, L. C., and Van Wijngaarden, N. J. "Model for Non-Steady Suspended Sediment Transport." (See complete entry in Section VI.)

Kieslich, J. M. 1977. "A Case History of Port Mansfield Channel, Texas," GITI Report 12, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents a case history and analysis of Port Mansfield channel, an artificial, jettied inlet between the Gulf of Mexico and Laguna Madre, Texas. Deposition has occurred in the channel entrance since its opening. Seaward migration of the updrift beach and shoaling in the channel entrance indicate that sand is bypassing the jettied entrance. Short-term predictions of inlet stability using the O'Brien prism-area relationship, Escoffier's stability criteria, and Bruun and Gerritsen ratio of tidal prism to the gross annual longshore transport rate, correctly predict the unstable nature of the channel. Tidal exchange volumes and velocities are not large enough to maintain the design cross-sectional area in the presence of the existing longshore transport. References (14 items).

Kirby, R., and Parker, W. R. 1982. "A Suspended Sediment Front in the Severn Estuary," Nature, 295(5848):396-399.

A zone of marked local gradient in the regional suspended solids field has been located along the axis of the Severn Estuary. This front occupies virtually the same position on ebb and flood and on spring and neap tides, although the amplitude of the gradient fluctuates. Thermohaline fronts have been described in coastal waters; suspended sediment fronts associated with the discharge of major rivers into the sea are common; while fronts caused by convergence of secondary circulations within estuaries have also been reported. References (12 items).

Kjerfve, B., ed. 1978. Estuarine Transport Processes, University of South Carolina Press, Columbia, S. C.

This book consists of 18 papers which were presented during 1976 at a symposium primarily concerned with the movement of water, salt, and fine-grained sediments in estuaries. Contents: "What Have Recent Observations Obtained for Adjustment and Verification of Numerical Models Revealed About the Dynamics and Kinematics of Estuaries," by Donald W. Pritchard; "Mixing Processes in Estuaries," by Kenneth F. Bowden; "Theoretical Aspects of Estuarine

Circulation," by Peter Hamilton and
Maurice Rattray, Jr.; "Some Simplified
Tidal Mixing and Circulation Flux Effects
in Estuaries," by Charles B. Officer; "A
Study of Turbulent Diffusion by Dye Trac-
ers: A Review," by Harry H. Carter and
Akira Okubo; "Role of Lateral Gradients
and Longitudinal Dispersion in the Salt
Balance of a Shallow, Well-Mixed Estuary,"
by Stephen P. Murray and Absornsuda Siri-
pong; "Micrometeorological Fluxes in Estu-
aries," by Shih-Ang Hsu; "The Balance of
Suspended Sediment in the Gironde and
Thames Estuaries," by Keith R. Dyer; "Sus-
pended Solids Transport in a Salt Marsh
Creek--An Analysis of Errors," by John D.
Boon III; "Vertical Transport of Suspended
Sediment in Upper Chesapeake Bay," by
Jerry R. Schubel, Robert E. Wilson, and
Akira Okubo; "Aggregation of Suspended
Particles in Estuaries," by Ray B. Krone;
"Sediment and Chemical Exchanges Between
Salt Marshes and Coastal Waters," by
Leonard R. Gardner and Wiley Kitchens;
"Some Aspects of Puget Sound's Circulation
and Water Properties," by Clifford A.
Barnes and Curtis C. Ebbesmeyer; "Winter
Replacement of Bottom Water in Puget
Sound," by Glenn A. Cannon and Curtis C.
Ebbesmeyer; "Deep Water Exchange in Alas-
kan Subarctic Fjords," by Robin D. Nuench
and David T. Heggie; "Physical Processes
in the Mediterranean Basins," by Thomas S.
Hopkins; "A Refined Method of Tidal Analy-
sis," by Alberto dos Santos Franco; "Epi-
logue: Where Do We Go From Here?" by
Bjorn Kjerfve, Keith R. Dyer, and Jerry R.
Schubel. References at end of each paper.

Knap, A. H., and Williams, P. J. LeB. "Ex-
perimental Studies to Determine the Fate
of Petroleum Hydrocarbons from Refinery
Effluent on an Estuarine System." (See
complete entry in Section VI.)

Knebel, H. J., et al. 1981. "Sedimentary
Framework of the Potomac River Estuary,
Maryland," Geological Society of America
Bulletin, Part I, 92(8):578-579.

Analyses of seismic reflection profiles,
sediment cores, grab samples, and side-
scan sonar records, along with previously
collected borehole data, reveal the char-
acteristics, distribution, and geologic
history of the shallow strata beneath the
Potomac River estuary. The lowermost
strata are sediments of the Chesapeake
Group (lower Miocene to lower Pleistocene)
that crop out on land near the shore but
are buried as much as 40 m below the floor
of the estuary. The top of these sedi-
ments is an erosional unconformity that
outlines the Wisconsinan valley of the
Potomac River. This valley has a sinuous
trend, a flat bottom, a relief of 15 to
34 m, and axial depths of 34 to 54 m below
present sea level. During the Holocene
transgression of sea level, the ancestral

valley was filled with as much as 40 m of
sandy and silty, fluvial-to-shallow estu-
arine sediments. The fill became the sub-
strate for oyster bars in the upper reach
and now forms most marginal slopes of the
estuary. Since sea level approached its
present position (2,000 to 3,000 years
ago), the main channel has become the
locus of deposition for watery, gray to
black clay or silty clay, and waves and
currents have eroded the heterogeneous
Quaternary sediments along the margins,
leaving winnowed brown sand on shallow
shoreline flats. Pb-210 analyses indicate
that modern mud is accumulating at rates
ranging from 0.16 to 1.80 cm/year, being
lowest near the mouth and increasing to-
ward the head of the estuary. This trend
reflects an increased accumulation of
fine-grained fluvial sediments near the
turbidity maximum, similar to that found
in nearby Chesapeake Bay. The present
annual accumulation of mud is about 1.54
million metric tons; the cumulative mass
is 406 million metric tons. References
(33 items).

Knox, S., et al. "Statistical Analysis of
Estuarine Profiles: II Application to
Arsenic in the Tamar Estuary (S.W. Eng-
land)." (See complete entry in Sec-
tion IV.)

Komar, P. D. Beach Processes and Sedimenta-
tion. (See complete entry in Section I.)

Kraft, J. C., John, C. J., and Maurmeyer,
E. M. 1978. "Morphology of Coastal Bar-
riers, Delaware, U.S.A.," Proceedings,
Sixteenth Coastal Engineering Conference,
August 27-September 3, 1978, Hamburg, Ger-
many, ASCE, II:1232-1244.

The Atlantic Coast of Delaware consists of
four separate but continuous segments in-
cluding (from north to south): (a) a
northward-projecting spit complex (Cape
Henlopen); (b) eroding Pleistocene head-
lands; (c) a linear coastal washover bar-
rier; and (d) an area of migrating inlets
with associated modern and relict ebb and
flood tidal deltas. Coastal process stud-
ies show that continuing coastal erosion
is accompanied by longshore transport of
sand eroded from headlands, offshore
transport to the nearshore marine area,
and overwash processes transporting sand
landward across the barrier. Studies of
the adjacent nearshore marine area show
that the barrier and its various geomor-
phic elements lay at the outer edge of the
continental shelf approximately 12,000
years ago, and migrated landward and up-
ward to the present position as the Holo-
cene marine transgression continued. The
sequence of coastal sediments of the bar-
rier system consists of (landward to sea-
ward) tidal marsh fringe, lagoonal muds
and sands, barrier sands (including

washover, dune, and beach deposits), and shallow nearshore sand and gravel. Drillhole studies provide information on the subsurface configuration of the barrier from which the three-dimensional structure and stratigraphy of coastal sedimentary environmental lithosomes may be defined. References (14 items).

Lake, C. A., and MacIntyre, W. G. 1977. "Phosphate and Tripolyphosphate Adsorption by Clay Minerals and Estuarine Sediments," Bulletin 109, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

This investigation sought to provide additional needed information on overenrichment of estuarine areas by examining the extent to which phosphate nutrients are taken up by clay sediments in estuarine and marine environments. Examined specifically was the adsorption of orthophosphate and tripolyphosphate by the four clay minerals most commonly found in ·irginia estuaries. A factorial analysis was applied to the design of the experiments in order to examine statistically the effect of pH, salinity, temperature, and initial phosphate concentration on orthophosphate adsorption. The main effects of pH and initial phosphate concentration were statistically important to orthophosphate adsorption. The amount of orthophosphate adsorbed by each of the clays increased in the following order: montmorillonite < kaolinite < illite < chlorite. The orthophosphate adsorption by synthetic clay demonstrated the generality of the adsorption experiments, for similar amounts were adsorbed by both synthetic and natural clays. When the source of phosphorus was tripolyphosphate rather than orthophosphate, each clay adsorbed more phosphorus under similar reaction conditions. References (53 items).

Leenknecht, D. A., Earickson, J. A., and Butler, H. L. "Numerical Simulation of Oregon Inlet Control Structures' Effects on Storm and Tide Elevations in Pamlico Sound." (See complete entry in Section VI.)

Lees, B. J., and Heathershaw, A. D. 1981. "Sizewell-Dunwich Banks Field Study, Topic Report 5; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data," Report No. 123, Institute of Oceanographic Sciences, Crossway, U.K. (Unpublished Manuscript).

Observed and predicted transport rates have indicated that for sand-size particles (d_{50} = 2.90, 130 μm), sediment is moved mainly in the suspended mode. Grain size analyses and subsequent calculations of transport rates for separate sand fractions show that the material transported is predominantly very fine sand. Logarithmic and power law relationships were used to predict bed-load sediment transport rates from midwater current meter data. Comparison with tracer experiment results showed that of five widely used sediment transport formulae, Yalin's (1963) equation gives the best predictions. References (54 items).

Lentsch, J. W., et al. "Stable Manganese and Manganese-54 Distributions in the Physical and Biological Components of the Hudson River Estuary." (See complete entry in Section IV.)

Lepetit, J. P., and Davesne, M. 1980. "Dynamics of Silt in Estuary, Residual Current or Flocculation Which Prevails?" Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2861-2873.

The transport of fine suspended sediment in a partly mixed estuary has been simulated on a physical model of a schematic estuary reproducing the main geometrical and hydrodynamical characteristics of the Gironde Estuary (France). The natural sediment consisting of silt and clay is simulated using a light and fine material, gilsonite, and the flocculation processes in salt water and under turbulence induced by tidal currents have been reproduced by adding to salt water a flocculating salt solution (sodium pyrophosphate). Then the formation of the turbidity maximum surveyed in the field and its upstream-downstream migration in response to varying river discharge have been successfully simulated and the results of different series of tests lead to the following conclusions: (a) Flocculation processes, which are responsible for the variation of the settling velocity with salinity and turbulence, have to be reproduced to explain the formation of the turbidity maximum. (b) After high river discharges, the convergence of bottom residual currents (null point) due to the salinity intrusion creates a trap for suspended sediments supplied by the river flood which accumulate in the form of the turbidity maximum. Without salinity intrusion, a large amount of sediment would escape out of the estuary to the sea. (c) During low river flows, a part of the suspended sediment migrates upstream, but the amplitude of this migration is small compared with the displacement of the upstream limit of the salinity intrusion. (d) The upstream migration of the turbidity maximum is increased when a transverse bottom morphology (existence of a deeper navigation channel) is represented. Reference (1 item).

Lepetit, J. P., and Hauguel, A. 1978. "A Numerical Model for Sediment Transport,"

Proceedings, Sixteenth Coastal Engineering
Conference, August 27-September 3, 1978,
Hamburg, Germany, ASCE, II:1715-1724.

A numerical two-dimensional model for
sediment transport which permits the com-
putation of the impact of a coastal struc-
ture on the bottom evolution is presented
in this paper. A simple kinematical study
of the sediment transport equation has
shown how the ripples propagation can be
obtained. It has also allowed a numerical
integration on a computer. The character-
istic response time of the surface wave
propagation compared to the characteristic
response time of the bottom evolution put
a stop to any sort of computation of the
disturbed current in the classical way.
The introduction of current disturbance
and several assumptions permit the compu-
tation of the bottom evolution during a
long time. This kinematical and mathe-
matical aspect almost understood, studies
are going on a more physical and dynamical
point of view to determine the influence
of the different parameters in transport
relationship and to find a best dynamical
approximation of the current disturbance.
At the same time, a means of averaging the
tide in tidal problems is investigated.
References (5 items).

Lin, P., Dai, Z., and Li, K. "Unsteady Flow
Studies in China." (See complete entry in
Section I.)

Lin, P., and Shen, H. 1984. "Two-D Flow
with Sediment by Characteristics Method,"
Journal, Hydraulic Engineering, ASCE,
110(5):615-626.

The theory of characteristics is applied
to analyze two-dimensional unsteady flow
over a bed of fine sediment. The sediment
is assumed to be so fine that suspension
is the predominant mode of transport. An
additional equation for sediment diffusion
is introduced. As a result, the number of
characteristics is increased, but the
characteristic directions can be deter-
mined without solving high-degree alge-
braic equations. Results from a one-
dimensional version of this procedure
agreed reasonably well with known data.
References (9 items).

Liou, Y.-C., and Herbich, J. B. 1977. "Ve-
locity Distribution and Sediment Motion
Induced by Ship's Propeller in Ship Chan-
nels," Hydraulics in the Coastal Zone,
Proceedings, 25th Annual Hydraulics Divi-
sion Specialty Conference, Texas A&M Uni-
versity, College Station, Texas, August
10-12, 1977, ASCE, 228-235.

A numerical model using the momentum the-
ory of the propeller and Shields' diagram
was developed to study sediment movement
induced by a ship's propeller in a
restricted waterway. The velocity

distribution downstream of the propeller
was simulated by the Gaussian normal dis-
tribution function. The shear velocity
and shear stress were obtained using
Sternberg's formulas. Once the ship's
speed, depth of the waterway, RPM and
diameter of the propeller, and draft of
the ship are given, the velocity distribu-
tion and the grain size of the initial mo-
tion could be obtained from this model.
Case studies are presented to show the
influence of significant factors on sedi-
ment movement at the channel bottom in-
duced by a ship's propeller. References
(7 items).

Ludwick, J. C. "Jet-Like Coastal Currents
and Bottom Sediment Transport off Virginia
Beach, Virginia." (See complete entry in
Section VIII.)

Ludwick, J. C., and Johnson, P. B. "Hydrau-
lic Sensor Instrumentation in a Shore Face
in a Tidal-Nontidal Coastal Convergence
Zone, Cape Henry, Virginia." (See com-
plete entry in Section VII.)

Lundgren, H. "Struggle of Physics and Math-
ematics." (See complete entry in Sec-
tion I.)

McAnally, W. H., Jr., et al. "Application
of Columbia Hybrid Modeling System." (See
complete entry in Section VI.)

McAnally, W. H., Jr., et al. "Columbia
River Estuary Hybrid Model Studies; Re-
port 1, Verification of Hybrid Modeling
of the Columbia River Mouth." (See
complete entry in Section VI.)

McCann, S. B., Reinson, G. E., and Armon,
J. W. "Tidal Inlets of the Southern Gulf
of St. Lawrence, Canada." (See complete
entry in Section I.)

McKay, G. R., and Tranberg, C. H. "The
Development of a Dredged Estuarine
Harbour--A Case Study." (See complete
entry in Section V.)

Macpherson, J. M. 1979/80. "Response to
Urbanization of the Avon-Heathcote Estu-
ary, Christchurch, New Zealand," Environ-
mental Geology, 3(1):23-27.

The Avon-Heathcote is a small, microtidal,
predominantly intertidal, weather-
dominated estuary. It has experienced
large alterations to its physical environ-
ment as a result of the establishment and
growth of the adjacent Christchurch City,
on what was previously a swampy, dune-
bordered coastal plain. During the first
25 years of settlement the volume of the
tidal compartment of the estuary decreased
from $7.7 \cdot 10^6$ m^3 to about $5 \cdot 10^6$ m^3. A
combination of rapid drain laying in the
1880s and 1890s and the conversion of much

of the catchment of the estuary to urban uses altered the sediment yields and run-off characteristics of the area and resulted in a reversal of the early trend. By 1925 the tidal compartment had returned to its original volume, and by 1975 it had reached a volume of 10.93 × 10⁶ m³. The early decrease was accompanied by widespread deposition of a 30- to 60-cm-thick layer of muddy sediment, some of which remains. The estuary inlet underwent major adjustments to accommodate the increasing tidal flow and now appears to be approaching a new, posturban equilibrium. References (18 items).

Madsen, O. S., and Grant, W. D. 1976. "Sediment Transport in the Coastal Environment," Technical Report No. 209, Massachusetts Institute of Technology, Cambridge, Mass.

The subject of sediment transport in the coastal zone is investigated, and the answers to some of the basic questions of sediment transport in unsteady, oscillatory flow are presented. A general numerical model is developed for the sediment transport and topographical changes resulting from spatially varying wave and current conditions. A simple numerical example of the evaluation of the topographical changes in the vicinity of the tip of a long straight breakwater is presented for periodic waves normally incident on the breakwater and a current parallel to the breakwater. References (43 items).

Magoon, O. T., and Baer, D. C. 1978. "Maintenance of Santa Cruz Harbor, California, USA," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1276-1281.

In planning and operating coastal harbors subjected to shoaling, it is imperative that the characteristics and regime of the sediments which deposit in the harbor entrance be quantified to the maximum extent possible in order that the economic impacts of shoaling in the channel and along adjacent shores may be evaluated. This paper presents a brief progress report on the study of a coastal harbor in an area subjected to shoaling. References (5 items).

Milliman, J. D., et al. 1984. "Tidal Phase Control of Sediment Discharge from the Yangtze River," Estuarine, Coastal and Shelf Science, 19(1):119-128.

Tidal phase plays a major role in controlling sediment discharge from the Yangtze River estuary in eastern China. Direct measurements indicate that during spring tide in mid-November 1981 approximately three times the sediment passed down the main channel of the river as during the next neap tide, 3 days later. The estuary presumably acts as a conduit for riverine sediment during spring tide but as a sink during neap tide. Tidal phase control of sediment discharge appears to be primarily dependent upon tidal range relative to estuarine depth rather than river discharge or absolute tidal range per se.

Mills, D. A., Colman, R. S., and Dandy, G. C. "Water Movement in a Complex Estuarine Embayment--A Methodology for Data Collection and Analysis." (See complete entry in Section VII.)

Monahan, D. 1976. "Morphology and Sediments of Sand Waves in the St. Lawrence Estuary," Maritime Sediments, 12(1):1-7.

Submarine sand waves have been reported from so many parts of the world that their occurrence is virtually commonplace. Nevertheless, the mechanism of their formation is not very well understood, and the numerous reports of various studies of sand waves present confusing and sometimes conflicting evidence. Generally, it has been reported that sand waves studied under natural conditions (a) migrate under the influence of the stronger tide or current; (b) reverse their asymmetrical orientation with change in tidal orientation; (c) contain some degree of selective sorting of grains within them; and (d) occur only where the bottom material is well-sorted sand. This paper reports on a short investigation of these phenomena as observed in the St. Lawrence estuary downstream from Quebec City. References (11 items).

Nakagawa, H., Tsujimoto, T., and Nakano, S. 1982. "Characteristics of Sediment Motion for Respective Grain Sizes of Sand Mixtures," Bulletin of the Disaster Prevention Research Institute, Kyoto University, Kyoto, Japan, Part 1, 32(286):1-32.

In sediment transport of sand mixture, the characteristic quantities of sand motion are different for each grain size, and it follows that temporal and spatial changes of bed constitution must be caused thereby. Therefore, the characteristic quantities of sand motion for each grain size should be clarified in relation to bed constitution to describe sediment transport process and subsequent phenomena in alluvial beds composed of sand mixtures. At first, mechanical properties of rough bed composed of sand mixture are investigated in relation to grain size distribution, and particularly the statistical properties of relative height and angle of escape of exposed particles are inspected by a simulation method. Next, the so-called critical tractive force for each grain size, which is one of the most fundamental quantities, is here

theoretically investigated. On its esti-
mation, the equivalent sand roughness of
mixed sand bed is necessary, and a new
model using the concept of equivalent size
of nonuniform particulate materials is
proposed. Moreover, the other character-
istic quantities of sediment motion for
each grain size are inspected based on a
film analyzing method. These research
projects must give important information
to describe various kinds of alluvial
phenomena observed in natural rivers of
which beds are composed of widely dis-
tributed sands and gravels. References
(20 items).

Nasner, H. 1978. "Time-Lag of Dunes for
Unsteady Flow Conditions," _Proceedings,
Sixteenth Coastal Engineering Conference,
August 27-September 3, 1978, Hamburg, Ger-
many_, ASCE, II:1801-1817.

In this paper, the time-dependent behavior
of dunes as a function of the governing
hydraulic conditions has been described.
The results can be summarized as follows:
(a) It has been proved that it is diffi-
cult to apply the results from experiments
on models to natural rivers. A clear-cut
relationship between bed form properties
and flow conditions may be given for
steady circumstances. In nature where
unsteady flows prevail, the bed configu-
ration adjusts itself to the changing
hydraulic conditions with a time lag.
However, also for significant dunes in
deepwater rivers, this is a short-term
process. (b) The knowledge gathered from
laboratory tests, according to which for
low Froude numbers and increasing veloci-
ties, higher dunes will be established,
obviously applies to limited water depths
only. The governing parameter for rivers
of greater depths is the flow velocity
which determines the limiting dune height
depending on the sediment characteris-
tics. In spite of the low Froude numbers,
the river bottom may be situated in the
transition zone. The dunes become smaller
by erosion for increasing discharges and
flow velocities. In case of falling water
levels and lower current velocities, the
bed forms may be enlarged again by sedi-
mentation. (c) The investigations re-
vealed that the river bottom shows a very
sensitive reaction to changed discharge
and flow conditions. The variations of
the dune height are of a remarkably
greater order of magnitude than the fluc-
tuations of the mean water level. On
principle, the dunes cause a stabilization
of the bottom so that the sediment removal
is reduced. Compared with a flat bed, the
sand transport is considerably reduced by
the merely local redistribution of the bed
material. In this respect, the dune
height is of minor significance, as the
height, as well as the migration velocity,

of the bed forms is governed by the mean
velocity of the flow and not inversely.
References (15 items).

Nece, R. E., and Forsyth, G. W. "Annotated
Bibliography on Tidal Flushing and Circu-
lation in Marinas." (See complete entry
in Section I.)

Nielsen, A. F., and Gordon, A. D. "Tidal
Inlet Behavioural Analysis." (See com-
plete entry in Section I.)

Nihoul, J. C. J., ed. _Marine Forecasting;
Predictability and Modelling in Ocean
Hydrodynamics; Proceedings, 10th Interna-
tional Liège Colloquium on Ocean Hydrody-
namics_. (See complete entry in Sec-
tion I.)

Nishimura, J. K., and Lau, L. S. "Structure
for Automatic Opening of Closed Stream
Mouths." (See complete entry in Sec-
tion V.)

Nishimura, J. K., and Lau, L. S. 1979.
"Structure for Automatic Opening of Sedi-
ment Plugs," _Coastal Structures 79, A Spe-
cialty Conference on the Design Construc-
tion, Maintenance and Performance of Port
and Coastal Structures_, March 14-16, 1979,
Alexandria, Virginia, ASCE, II:1106-1123.

Closure of stream mouths by littoral sedi-
ment is a natural condition of numerous
small streams on islands like Oahu, Ha-
waii. Flood damages induced by floodwater
flowing over banks before the blockage is
either breached or overtopped can be sub-
stantial especially in urbanized areas.
Solutions to the problem may be achieved
by preventing the formation by using jet-
ties or other similar structures or by
removing or breaching the blockage in time
before flooding. The first approach is
often infeasible for small streams. Me-
chanical dredging is expensive and ef-
fective only if done in time and only for
a limited period of time. There are in
use hydraulic structures that utilize the
hydraulic forces of the early arriving
storm flow to breach the blockage. A new
design of a hydraulic structure with non-
moving parts for automatic opening of
coastal sediment plugs at small stream
mouths has been developed. When posi-
tioned properly in the stream mouth, the
structure will induce piping and erosion
of the sediment plug progressing from the
ocean side toward the stream and result-
ing in prompt failure of the sediment plug
and passage of the flood flow. References
(8 items).

Novak, P., and Čábelka, J. _Models in
Hydraulic Engineering; Physical Principles
and Design Applications_. (See complete
entry in Section VI.)

Nummedal, D., and Fischer, I. A. 1978. "Process-Response Models for Depositional Shorelines: The German and the Georgia Bights," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1215-1231.

Sediment dispersal patterns in tidal inlets within the German and the Georgia Bights are found to be controlled by three major environmental factors: (a) the tide range, (b) the nearshore wave energy, and (c) the geometry of the back-barrier bay. Both embayments chosen for study are characterized by high wave energies and low tide ranges on their flanks, and low wave energies and high tide ranges in their centers. The spatial variability in inlet morphology, therefore, contains information on the relative role of tides and waves in inlet sediment dispersal. The paper concludes by proposing a simple model for inlet morphologies for successively greater relative role of tidal currents in the sediment dispersal. References (25 items).

O'Brien, M. P. "Comments on Tidal Entrances on Sandy Coasts." (See complete entry in Section I.)

O'Connor, D. J., and Lung, W. "Suspended Solids Analysis of Estuarine Systems." (See complete entry in Section VI.)

O'Connor, D. J., Mueller, J. A., and Farley, K. J. "Distribution of Kepone in the James River Estuary." (See complete entry in Section IV.)

Odd, N. V. M., and Baxter, T. "Port of Brisbane Siltation Study." (See complete entry in Section VI.)

"Old Laboratory Tests Large Coastal Models." (See complete entry in Section VI.)

Olsen, C. R., et al. "Reactor-Released Radionuclides and Fine-Grained Sediment Transport and Accumulation Patterns in Barnegat Bay, New Jersey, and Adjacent Shelf Waters." (See complete entry in Section IV.)

Onishi, Y. "Sediment-Contaminant Transport Model." (See complete entry in Section VI.)

Onishi, Y., et al. 1981. "Critical Review: Radionuclide Transport, Sediment Transport, and Water Quality Mathematical Modeling; and Radionuclide Adsorption/Desorption Mechanisms," NUREG/CR-'322, PNL-2901, US Nuclear Regulatory Commission, Washington, D.C.

This report describes the results of a detailed literature review of radionuclide

transport models applicable to rivers, estuaries, coastal waters, the Great Lakes, and impoundments. Some representative sediment transport and water quality models were also reviewed to evaluate if they can be readily adapted to radionuclide transport modeling. References (1,112 items).

Owen, M. W., and Thorn, M. F. C. 1978. "Effect of Waves on Sand Transport by Currents," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1675-1687.

The effect of waves on the transport of sand in suspension by currents can be especially important in the outer regions of estuaries and tidal inlets. This paper presents two series of field experiments carried out to investigate the transport of sand under the combined action of waves and currents.

Özsoy, E., and Ünlüata, Ü. "Ebb-tidal Flow Characteristics near Inlets." (See complete entry in Section I.)

Partheniades, E. 1973. "Engineering Properties of Estuarine Sediments," NATO Advanced Study Institute on Estuary Dynamics, Lecture No. 16, Laboratório Nacional de Engenharia Civil, Lisbon, Portugal.

This paper presents the importance of sedimentation in estuaries, general formulation of the sediment transport and deposition, physicochemical properties of cohesive sediments related to their depositional and erosional behavior, and erosion and deposition of cohesive soils. The most important engineering properties of fine estuarine sediments which affect their hydrodynamic behavior on a flow field have been summarized and formulated in a simplified mechanistic form to explain the observed erosional and depositional phenomena. It was concluded that the net attractive interparticle forces play a dominant role in erosion and deposition of cohesive soils by providing the main resistance to erosion and the principal mechanism for flocculation. References (38 items).

Pethick, J. S. 1981. "Long-Term Accretion Rates on Tidal Salt Marshes," Journal of Sedimentary Petrology, 51(2):571-577.

Long-term variations in salt marsh accretion rates were estimated using data collected on the marshes of the North Norfolk coast, England. Fourteen discrete marsh areas were sampled, all lying within a 20-km stretch of coast. The age of each marsh had previously been determined using radiocarbon or archival evidence for the date of vegetation inception on each marsh surface. Marsh ages ranged from '0 years

to +2,000 years. The elevation of each marsh surface was determined in the field using levelling techniques. The relationship between age and surface elevation was assumed to be a function of the rate of marsh accretion within this area of coast. Statistical tests showed this to be a highly significant relationship while the accretion rates calculated from the age/height curve agree closely with field measurements on these marshes. Accretion rates were found to vary from 1.7 cm/year on 10-year-old marshes to less than 0.002 cm on marshes older than 500 years. The age/height relationship describes an asymptotic curve with the asymptote lying 0.8 m below the level of the highest spring tides, and appears to be controlled by the frequency of tidal maxima which peaks at 0.8 m below the maximum value and declines sharply above that height. References (14 items).

Philip, N. A. "Coastal Processes and the Wagonga Inlet Breakwaters." (See complete entry in Section I.)

Pickrill, R. A., Irwin, J., Shakespeare, B. S. 1981. "Circulation and Sedimentation in a Tidal-Influenced Fjord Lake: Lake McKerrow, New Zealand," *Estuarine, Coastal and Shelf Science*, 12(1):23-37.

Lake McKerrow is a tide-influenced fjord lake, separated from the open sea by a Holocene barrier spit. Fresh, oxygenated waters of the epilimnion overlie saline, deoxygenated waters of the hypolimnion. During winter, water from the Upper Hollyford River interflows along the pycnocline, depositing coarse silt on the steep delta and transporting finer sediment down lake. An extensive sublacustrine channel system on the foreset delta slope is possibly maintained by turbidity currents. Saline waters of the hypolimnion are periodically replenished. During high tides and low lake levels, saline water flows into the lake and downslope into the lake basin as a density current in a well-defined channel. References (27 items).

Price, W. A., Motyka, J. M., and Jaffrey, L. J. "The Effect of Offshore Dredging on Coastlines." (See complete entry in Section V.)

Pruszak, Z., and Zeidler, R. B. 1978. "Sediment Transport and Ripples Due to Waves and Currents," *Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany*, ASCE, II:1638-1655.

Water velocities and shear stresses have been determined for a laminar boundary layer of a progressive wave travelling over a regular series of ripples. The Lavrentiev variational method was used to transform conformally the water area with

ripples into a strip with flat bottom, while the Lin approach permitted solution of the boundary layer equation. The theoretical prediction of the bed friction was verified experimentally with a new mechanical apparatus. By coupling the theoretical shear stress at the rippled bed with laboratory data for ripple parameters, one can expose the friction conditions that control the growth and decay of ripples. If waves develop higher values of shear stress, the rippled bed becomes gradually washed out. For known shear stresses, based on the Frijlink-Bijker formula, one can compute sediment transport rates. In the respective diagram, a curve of sediment transport rate versus bottom friction consists of two branches. The stages of the growth and decay of ripples are reflected in the lower and upper branches of the curve. For identical ripple height, there are two values of sediment transport rate, for two different wave intensities, likely to differ by as much as 25 percent. Three-dimensional ripples have been analyzed with regard to bed friction and compared with two-dimensional conditions. References (6 items).

Ramming, H.-G. "The Influence of River Normalization on the Distribution of Tidal Currents in the River Elbe." (See complete entry in Section I.)

Rashid, M. A., and Reinson, G. E. 1979. "Organic Matter in Surficial Sediments of the Miramichi Estuary, New Brunswick, Canada," *Estuarine and Coastal Marine Science*, 8(1):23-36.

The surficial sediments of the Miramichi Estuary, New Brunswick, contain a much higher quantity of organic matter than would be expected to occur in an estuary of this type, which is shallow and well mixed. The organic carbon distribution in general corresponds with the distribution of fine-grained sediment, although higher concentrations occur in sediments of the drowned river channel than in sediments of the bay portion of the estuary. The high quantity of organics in all the sediments and differences in concentrations between river channel and bay sediments are the direct result of the discharge of pulp mill effluent into the upper reaches of the estuary. The organic carbon isotopic composition of sediments suggests that land-derived material is the predominant source of organics throughout the estuary. Marine organic material is restricted to the sediments near the estuarine mouth. Dispersal of the organic matter is achieved largely by transport in the upper freshwater effluent layer, and by settling through the water column when transport energies are reduced. Settling of organic matter is highest in areas where

deposition of fine-grained inorganics prevails. References (26 items).

Renger, E., and Partenscky, H. W. "Sedimentation Processes in Tidal Channels and Tidal Basins Caused by Artificial Constructions." (See complete entry in Section I.)

Renwick, W. H., and Ashley, G. M. "Sources, Storages, and Sinks of Fine-Grained Sediments in a Fluvial-Estuarine System." (See complete entry in Section IV.)

Roberts, H. H. 1980. "Physical Processes and Sediment Flux Through Reef-Lagoon Systems," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, I:946-962.

Studies of physical processes in reef-lagoon systems continue to emphasize the importance of waves and wave-induced currents at the reef crest as agents of sediment transport to back reef environments. These across-the-reef currents are also largely responsible for driving back reef lagoon circulation. Rapid energy transformations associated with the process of wave breaking at the reef crest are responsible for strong reef-normal surge currents. Estimates of energy loss, as determined by wave height changes caused by wave breaking, can be as high as 70-80 percent for discontinuous reefs and >90 percent for continuous examples. The amount of energy loss is related to depth of water over the reef crest, a function of reef topography and tidal regime. Low-tide conditions promote the greatest incident wave modification and attenuation as a result of increased breaking wave intensity. Under trade wind conditions found in the Caribbean, surge currents of 50-80 cm/sec for durations of 2-6 sec are common in a low to moderate wave energy setting (4- to 6-sec input waves, 40- to 50-cm average heights). Sediments through the sand sizes up to pebbles are easily transported lagoonward by these periodic bursts of energy. Flow in shallow back reef lagoons (generally <3 km wide) is driven largely by across-the-reef currents resulting from breaking waves. Long, unbroken reefs tend to induce axial currents in the back reef lagoon which flow roughly parallel to the reef trend. Side-scan sonographs indicate that large bed forms define a region of bottom sediment migration related to strong currents down the lagoon axis, presumably activated during periods of abnormal wave activity on the reef. Localized and discontinuous shallow reefs tend to store coarse sediments in the back reef in sand bodies oriented at high angles to the reef trend. Combined effects of wave refraction and tidal exchange around the flanks of these localized reef masses give rise to

tombololike sediment accumulations in the shallow back reef area. Back reef sand bodies associated with continuous linear reefs tend to be oriented parallel to the reef trend. Lagoonal sediments are transported through tidal passes to the forereef shelf, where sediment sinks commonly develop behind actively growing shelf margin reefs. Side-scan sonar and high-resolution subbottom data confirm both sediment sinks and preferential offshelf transport routes on narrow, rough-bottomed forereef shelves. In trade wind-island systems (e.g., Grand Cayman and St. Croix), sediments are stored in large quantities on the forereef shelf at the downwind flanks of the islands. Forereef shelf morphology indicates that at these same locations, routes for offshelf sediment transport are optimized. References (19 items).

Rodger, J. G. 1980. "Simulation of Stratified Flows in Estuaries," Proceedings, Second International Symposium on Stratified Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:707-721.

The transport of suspended material or dissolved salt or pollutant in an estuary depends on two main fluid processes: advection and vertical mixing. In a shear flow, different rates of advection of concentrates then lead to longitudinal dispersion. It is not possible to model water movement separately from the transport processes if the flow field is influenced by the density effects of suspended or dissolved substances. Although the dominant fluid motion in an estuary is still governed by the tide in the sea and the fluvial discharge in the upper estuary, density gradients between the sea and the estuary can generate a gravitational circulation with a net flow in the landward direction near the bed of the estuary. This gravitational circulation plays an important role in the distribution of sediments in many estuaries. In addition, vertical density gradients reduce the vertical mixing, so tending to preserve the vertical and horizontal structure of the flow. These secondary effects play an important role in the transport processes; and in order to simulate them, a two-dimensional laterally averaged model of estuarine flow was developed at the Hydraulics Research Station (Miles 1977). This paper describes a general two-dimensional laterally averaged model of salt intrusion and sediment transport incorporating a general expression for vertical turbulent exchange in a partially mixed estuary. Because of the method used to integrate the governing equations, this type of model is sometimes referred to as a multilayer model. The paper also

describes some results of the model's first application to a real estuary. References (8 items).

Seabergh, W. C. "Weir Jetty Performance: Hydraulic and Sedimentary Considerations; Hydraulic Model Investigation." (See complete entry in Section V.)

Seabergh, W. C., and Lane, E. F. "Improvements for Little River Inlet, South Carolina; Hydraulic Model Investigation." (See complete entry in Section VI.)

Seabergh, W. C., and Sager, R. A. "Supplementary Tests of Masonboro Inlet Fixed-Bed Model; Hydraulic Model Investigation." (See complete entry in Section VI.)

Seelig, W. M., and Sorensen, R. M. "Numerical Model Investigation of Selected Tidal Inlet-Bay System Characteristics." (See complete entry in Section VI.)

Sengupta, S., Lee, S. S., and Miller, H. P. "Three-Dimensional Numerical Investigations of Tide and Wind-Induced Transport Processes in Biscayne Bay." (See complete entry in Section VI.)

Sharp, J. J. Hydraulic Modelling. (See complete entry in Section VI.)

Shelley, P. E. 1976. "Sediment Measurement in Estuarine and Coastal Areas," NASA CR-2769, National Aeronautics and Space Administration, Wallops Island, Va.

The discussion begins with a survey of uses of estuarine and coastal areas. Problems associated with these uses are discussed, and data needs for intelligent management of these valuable areas are outlined. Suspended sediment measurements are seen to be one of the greatest needs. To help understand the complexity of the problem, a brief discussion of sediment mechanics is given, including sediment sources, characteristics, and transport. The impact of sediment mechanics on its direct measurement (sampling and analysis) is indicated, along with recommendations for directly obtaining representative data. Indirect measurement of suspended sediment by remote sensors is discussed both theoretically and in the light of some recent experiences. The need for an integrated, multidisciplinary program to solve the problem of quantitatively measuring suspended sediment with remote sensors is stressed, and several important considerations of such a program and benefits to be derived therefrom are briefly addressed. It is recommended that the present, very preliminary look be expanded into a full-blown program plan for developing a timely and affordable solution to the problem. References (4 items).

Sheng, Y. P. "Mathematical Modeling of Three-Dimensional Coastal Currents and Sediment Dispersion: Model Development and Application." (See complete entry in Section VI.)

Siefert, W., and Barthel, V. "The German 'MORAN' Project." (See complete entry in Section I.)

Smith, N. P., and Kierspe, G. H. "Local Energy Exchanges in a Shallow, Coastal Lagoon: Winter Conditions." (See complete entry in Section VI.)

Smith, T. J., and O'Connor, B. A. "A Two-Dimensional Model for Suspended Sediment Transport." (See complete entry in Section VI.)

Sorensen, R. M. "The Corps of Engineers General Investigation of Tidal Inlets." (See complete entry in Section I.)

Sorensen, R. M., and Schmeltz, E. J. "Closure of the Breach at Moriches Inlet." (See complete entry in Section V.)

Stephens, H. S., and Stapleton, C. A., ed. Papers Presented at the Second International Symposium on Wave and Tidal Energy, September 23-25, 1981, Cambridge, England. (See complete entry in Section I.)

Sternberg, R. W., et al. "Aquatic Disposal Field Investigations, Columbia River Disposal Site, Oregon; Appendix A: Investigations of the Hydraulic Regime and Physical Nature of Bottom Sedimentation." (See complete entry in Section V.)

Stevens, H. H., et al. "Model for Sediment Transport Through an Estuary Cross Section." (See complete entry in Section VI.)

Streif, H. 1978. "A New Method for the Representation of Sedimentary Sequences in Coastal Regions," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1245-1256.

Coastal lowlands usually consist of a body of unconsolidated sediments of up to 300-m thickness which have been deposited under the influence of a rising sea level. These lowlands increasingly are acquiring importance for industrial plants, harbor construction, pipelines, and the exploration of mineral resources. Geological mapping at a scale of 1:25,000 is of fundamental importance in the planning that is required which will permit an economic exploitation of the coastal zone. The newest type of geologic map--the sequence map--offers the possibility of an easy and comprehensive representation that permits even the non-geologist to distinguish between different kinds of sediment.

range of application covers tidal flat areas, marshes, and coastal bogs. Combined with a documentation system of the field data and the techniques of automatic data processing, this type of map offers new aspects which by far exceed the possibilities of conventional geological mapping. References (8 items).

Stumpf, R. P. 1983. "The Process of Sedimentation on the Surface of a Salt Marsh," Estuarine, Coastal and Shelf Science, 17(5):495-508.

An unditched salt marsh-creek drainage basin (Holland Glade Marsh, Lewes, Delaware) has a sedimentation rate of 0.5 cm year^{-1}. During normal, storm-free conditions, the creek carries negligible amounts of sand and coarse silt. Of the material in the waters flooding the marsh surface, over 80 percent disappears from the floodwaters within 12 m of the creek. About one-half of the lost material is theoretically too fine to settle, even if flow were not turbulent; however, sediment found on *Spartina* stems can account for the loss. The quantity of suspended sediment that does reach the back marsh during these normal tides is inadequate to maintain the marsh surface against local sea level rise. This suspended sediment is also much finer than the deposited sediments. Additionally, remote sections of low marsh, sections flooded by only the highest spring tides, have 15-30 cm of highly inorganic marsh muds. This evidence indicates that normal tidal flooding does not produce sedimentation in Holland Glade. Study of the effects of two severe storms, of a frequency of once per year, suggests that such storms can deposit sufficient sediment to maintain the marsh. The actual deposition of fine-grained sediments (fine silt and clay) appears to result primarily from biological trapping rather than from settling. In addition, this study proposes that the total sedimentation on mature marshes results from a balance between tidal and storm sedimentation. Storms will control sediment supply and movement on micro- and meso-tidal marshes, and will have less influence on macro-tidal marshes. References (3 items).

Sundermann, J., and Holz, K.-P., ed. Mathematical Modelling of Estuarine Physics, Lecture Notes on Coastal and Estuarine Studies. (See complete entry in Section I.)

Sundermann, J., and Krohn, J. 1977. "Numerical Simulation of Tidal Caused Sand Transport in Coastal Waters," Proceedings, Seventeenth Congress of the International Association for Hydraulic Research; Hydraulic Engineering for Improved Water Management, 15-19 August 1977,

Baden-Baden, Federal Republic of Germany, 1:173-181.

A numerical model of the large-scale horizontal sediment transport caused by tidal currents is developed. The investigations are based on a two-dimensional horizontal model which produces the tidal velocity field depending on space and time within one $(M_2 + S_2)$ tidal cycle. These velocities are reduced to the acting shear stress velocities near the bottom. For the beginning and the end of the sediment transport, different critical shear stresses are assumed depending on the grain sizes. After integration over one spring-neap cycle, the net transport and the material budget for various coastal regions of the North Sea are calculated. References (7 items).

Sundermann, J., Vollmers, H., and Puls, W. "The Influence of Dune and Flow Parameters on the Friction Factor." (See complete entry in Section VI.)

Svasek, J. N., and Versteegh, J. "Mathematical Model for Quantitative Computations of Morphological Changes Caused by Man-Made Structures Along Coasts and in Tidal Estuaries." (See complete entry in Section VI.)

Therriault, J. C., Ladurantaye, R. de, and Ingram, R. G. 1984. "Particulate Matter Exchange Across a Fjord Sill," Estuarine, Coastal and Shelf Science, 18(1):51-64.

Recent studies have indicated the existence of a considerably higher planktonic biomass in the deep waters of the Saguenay Fjord as compared to corresponding depths in the adjacent St. Lawrence Estuary on the other side of a shallow sill. The hypothesis that has been put forward to explain this phenomenon is related to the advection of near-surface estuarine waters, at times very rich in particulate matter, over the entrance sill into the deeper waters of the fjord. Mixing processes associated with the development of a density flow, the presence of a hydraulic jump, or other mechanisms are assumed to be responsible for the common occurrence of lower density subsurface water within the basin as compared to that penetrating over the sill. The exchange processes between the estuary and the fjord are described and an estimate made of the estuarine water volume that penetrates into the lower layer of the fjord over a semidiurnal tide cycle. From these calculations, the replacement time for the outer basin was estimated to range between 1 and 4 days. The biological characteristics of this water were used to establish a budget for particulate matter exchange which showed, in early August, a typical net input of 488 tons of particulate organic carbon into the deep waters of the

fjord over one tide cycle. References
(20 items).

Thienpont, M., and Berlamont, J. "Mathemat-
ical Modelling of Th: mal Discharge in
Rivers and Estuaries." (See complete
entry in Section VI.)

Thimakorn, P., and Gupta, A. D. 1978.
"Concentration of Suspended Clay in Tidal
Estuary," Proceedings, International Con-
ference on Water Resources Engineering,
Asian Institute of Technology, Bangkok,
Thailand, January 10-13, 1978, I:173-192.

In the tidal estuary of a large river
where the bed materials are of soft clay,
the sediments are carried in suspension.
The suspended load transports are esti-
mated from the known values of the concen-
tration of the suspended solid and the ve-
locity of tidal current. The values of
the suspended solid concentration used in
the estimation can be obtained from field
measurements. Such data are always avail-
able only for short duration because of
the time limitation allowed for field ob-
servation. Information on the amount of
sediment transport is always required on a
long-term basis; therefore, data on the
concentration of the suspended solid ob-
tained from the field alone may not be
adequate for that purpose. As such, the
field data of limited duration have to be
extrapolated to obtain the values which
are not available to facilitate the esti-
mation of the long-term sediment trans-
port. A method to extrapolate the limited
number of field data of the suspended
solid concentration in a tidal estuary is
developed by correlating the average con-
centration over a cross section of the
estuary with the velocity of the current.
Since the suspended sediment entering an
estuary is carried along by the riverflow
and the amount of the riverflow has direct
effect on the sediment transport, the ef-
fect of riverflow variation is indicated
in the extrapolation process. Data ob-
tained from the field measurements which
had been conducted at time intervals over
a period of 1 year in the four estuaries
in Thailand are used in the analysis. The
result thus obtained shows that the data
extrapolation method proposed would be ap-
plicable for the estuary having similar
characteristics, considered in this study.
References (7 items).

Thompson, G. B., and Yeung, S. K. "Phospho-
rus and Organic Carbon in the Sediments of
a Polluted Subtropical Estuary, and the
Influence of Coastal Reclamation." (See
complete entry in Section IV.)

Thorn, M. F. C. 1979. "The Effect of Waves
on the Tidal Transport of Sand," HRS
Notes, Hydraulics Research Station, Wal-
lingford, Oxfordshire, England, 2:4-5.

The construction by the Department of the
Environment of a survey tower on the edge
of the Maplin Sands in the Outer Thames
estuary has now provided a means by which
the tidal transport of sand can be mea-
sured under varying wave conditions. Over
a period of 2 years, data were collected
during storms and calms to provide a broad
basis of assessment of the relative impor-·
tance of wave action in tidal sediment
transport. The results have led to the
definition of a threshold condition below
which wave effect can be ignored, and they
have also shown that the wave action above
the threshold causes a substantial in-
crease in the flux of sand transported by
the tide. They thus provide the basis for
a better estimation of long-term estuarine
transport of sand and consequential silta-
tion from conventional survey data. The
range of data was restricted by the natu-
rally occurring wave climate at Maplin
Sands. The effect of larger waves is be-
ing investigated elsewhere.

Vallianos, L. "Barden Inlet, N.C.: A Case
Study of Inlet Migration." (See complete
entry in Section V.)

van de Kreeke, J., and Haring, J. 1980.
"Stability of Estuary Mouths in the Rhine-
Meuse Delta," Proceedings, Seventeenth
Coastal Engineering Conference, March 23-
28, 1980, Sydney, Australia, ASCE,
III:2627-2639.

The Rhine-Meuse Delta in the southwestern
part of The Netherlands consists of sedi-
ment deposits of the Rhine and the Meuse
in which tides and riverflow have scoured
an intricate system of channels. The four
major estuaries are from south to north
Eastern Scheldt, Brouwershavense Gat,
Haringvliet, and Rotterdam Waterway. The
connection between estuaries and rivers is
formed by a system of branching channels,
referred to as tidal rivers. The flow in
the tidal rivers is constrained by dikes,
revetments, and groins. It is in this
region where most of the sand fraction of
the sediments carried by the rivers Rhine
and Meuse is deposited. Extensive mainte-
nance dredging is required to maintain a
sufficiently large cross section for navi-
gation. The mud fraction (all sediments
with grain size <62 µ) of the river sedi-
ments is carried further seaward and is
partly deposited in the estuaries and
partly in the offshore underwater delta.
Average tidal ranges at the seaward bound-
ary of the delta decrease going from south
to north and vary between 3.78 m at Flush-
ing to 1.58 m at Hook of Holland. The
ratio of average tidal range to average
spring tidal range is approximately 0.86.
Tides are predominantly semidiurnal. The
average annual discharges of the Rhine and
Meuse are respectively 2,200 m³ sec and
250 m³ sec. Discharges of both rivers

show seasonal fluctuations with a maximum
in the winter and a minimum at the end of
the summer. *The river water is distrib-*
uted over the estuaries in varying propor-
tions; e.g., in 1959 the ratios of the
average river volume to the average flood
volume for the estuaries Eastern Scheldt,
Brouwershavense Gat, Haringvliet, and
Rotterdam Waterway were respectively 0, 0,
0.25 and 0.53. In the offshore region
there exists a longshore sand motion to
the north with a transport rate on the
order of 50,000 m³/year. Associated with
the longshore motion is a fining of the
bottom sand when going from south to
north. Typical values for the mean grain
diameter of the sand are 200 μ for the
mouth of the Eastern Scheldt and 150 μ for
the mouth of the Haringvliet (Terwindt
1973). The present shape of the delta is
to a large extent the result of man's in-
terference with the natural sedimentation
processes, the expansion of the port of
Rotterdam, maintenance dredging, and in
particular the delta project. The delta
project envisions the closure of the East-
ern Scheldt, Brouwershavense Gat, and
Haringvliet. To properly manage the delta
and in particular to minimize maintenance
dredging and to prevent dike calamities,
it is important to be able to predict
scour and shoaling associated with the
various man-made modifications. For this
purpose, empirical relations between char-
acteristics of cross section and flow are
derived using observations in the Rhine-
Meuse Delta, prior to the delta project.
References (8 items).

Van Vleet, E. S., and Quinn, J. G. "Input
and Fate of Petroleum Hydrocarbons Enter-
ing the Providence River and Upper Nar-
ragansett Bay from Wastewater Effluents."
(See complete entry in Section IV.)

Vongvisessomjai, S., and Srikanthan, R.
"The Regimen of Takuapa Tidal Channel."
(See complete entry in Section I.)

Vreugdenhil, C. B. "Application of Finite-
Difference Methods to Estuary Problems."
(See complete entry in Section I.)

Wade, T. L., and Quinn, J. G. "Incorpora-
tion, Distribution and Fate of Saturated
Petroleum Hydrocarbons in Sediments from
a Controlled Marine Ecosystem." (See com-
plete entry in Section IV.)

†Wadsworth, J. R., Jr. "Geomorphic Charac-
teristics of Tidal Drainage Networks in
the Duplin River System, Sapelo Island,
Georgia." (See complete entry in Sec-
tion I.)

Wadsworth, J. R., Jr. "Structural Control
of Drainage Morphology of Salt Marshes on
St. Catherine's Island, Georgia." (See
complete entry in Section I.)

Wang, Y.-H. "Satellite Applications on a
Coastal Inlet Stability Study." (See
complete entry in Section VII.)

Ward, G. H., Jr. "Pass Cavallo, Texas; Case
Study of Tidal-Prism Capture." (See
complete entry in Section V.)

Ward, L. G. 1978. "Hydrodynamics and Sedi-
ment Transport in a Salt Marsh Tidal Chan-
nel," Proceedings, Sixteenth Coastal Engi-
neering Conference, August 27-September 3,
1978, Hamburg, Germany, ASCE, II:1953-
1969.

Processes and sediment transport were in-
vestigated in a salt marsh drainage system
at Kiawah Island, South Carolina. A
general survey of the tidal current was
done in the major tidal channel (Bass
Creek) for a 10-tidal-cycle period in
August 1977. Detailed determinations of
current velocity, discharge, and suspended
load were conducted during 15 tidal cycles
in March 1977 and again during 8 tidal cy-
cles in July-August 1977. For each of
these periods, mass budget for the total
suspended load was computed. The tidal
currents have a pronounced time velocity
asymmetry with the maximum current veloc-
ity occurring nearer high slack water and
the peak ebb velocity being 20-30 percent
stronger than the flood. Suspended load
transport is significantly affected by the
time velocity asymmetry. Peak current oc-
curring nearer high slack water causes a
net displacement of suspended material in
an ebb or seaward direction under normal
conditions. This process is enhanced by
the stronger ebb currents. Mass budgets
reflect the ebb dominance of the system
showing a net export of combustible (or-
ganic) material during the March sampling
period and a net export of both noncombus-
tible (inorganic) and combustible material
during the July-August period. Also im-
portant to suspended load transport in
marsh systems are stressed meteorological
conditions. High winds or heavy rains in-
crease suspended load concentration and
can cause significant import or export of
fine-grained material. References
(22 items).

Wells, J. T., Coleman, J. M., and Wiseman,
W. J., Jr. 1978. "Suspension and Trans-
portation of Fluid Mud by Solitary-Like
Waves," Proceedings, Sixteenth Coastal
Engineering Conference, August 27-
September 3, 1978, Hamburg, Germany, ASCE,
II:1932-1952.

The suspension and transportation of fluid
muds in the nearshore zone by shallow-
water, solitary-like waves have been in-
vestigated along the coast of Surinam,
South America. Accumulations of fluid mud
which front the coast at a spacing of 30-
60 km affect incoming swell by changing
the wave profile from sinusoidal to

solitary-like and by preventing wave breaking except for occasional spilling. Simultaneous time-series measurements of wave height and period, fluid-mud density, and tide elevation, along with results of suspended-sediment measurements, indicate that in cases when the bulk density is less than 1.20 g/cm³ and where water depths are less than 5 m, fluid mud is suspended from the bottom in two frequency modes: wave-by-wave suspension (~10 sec) and tide-related suspension (~12.4 hr). Surface-water suspensate concentrations exceed 3.4×10^3 mg/ℓ as up to 0.5 m of fluid mud is periodically removed from the bottom. High concentrations of suspended fluid mud, together with solitary-like waves from the northeast throughout the year, can lead to extraordinarily high sediment transport volumes. Calculations based on solitary wave theory and on data obtained from this study indicate that $15\text{-}65 \times 10^6$ m³ of mud can move alongshore each year without involving breaking waves, the concept of radiation stress andsa nearshore circulation cell, or bed-load transport. These values are 10 to 100 times greater than typical transport rates along sandy coasts. References (26 items).

Williamson, A. N. "Movement of Suspended Particles and Solute Concentrations with Inflow and Tidal Action." (See complete entry in Section VIII.)

Wong, G. T. F., and Moy, C. S. 1984. "Cesium-137, Metals and Organic Carbon in the Sediments of the James River Estuary, Virginia," Estuarine, Coastal and Shelf Science, 18(1):37-49.

A wide variety of sedimentary subenvironments are found within a 10-km stretch of James River including a flood-dominated channel (Rocklanding Channel) and its bank (Rocklanding Shoal), a shoal with a water depth of 1 m separating two channels (Point of Shoals), an ebb-dominated channel (Burwell Bay Channel) and its bank (Burwell Bay Bank), and a tributary (Warwick River). The concentrations of Cs-137, copper, lead, zinc, and organic carbon in the fine-grained sediments (i.e., <63 um) and the amount of fine-grained sediments in eight cores covering these subenvironments were determined. The sedimentation rates, estimated by Cs-137 geochronology, range from 0.4 to >3 cm year⁻¹. The sedimentation rates in the Burwell Bay region are two or more times those in the Point of Shoals and in the Rocklanding Channel and Shoal, reflecting the weaker currents in the Burwell Bay region. These sedimentation rates agree well with those obtained independently by measuring changes in the bathymetry of this area between 1873 and 1943. The concentrations of Cs-137,

copper, lead, zinc, and organic carbon in surface sediments vary by a factor of two to three. The concentrations are higher in the Burwell Bay region, probably as a result of the higher rates of accumulation of recently formed sediments in these sub-environments. The inventories of fine-grained sediments and of Cs-137, copper, lead, zinc, and organic carbon accumulated since 1954 are also up to an order of magnitude higher in the Burwell Bay region. Although the concentrations of fine-grained sediments in three cores obtained in this region are similar, the inventories still vary by a factor of two to three. The inventories of Cs-137, copper, lead, zinc, organic carbon, and fine-grained sediments correlate well with each other indicating that Cs-137 can be a useful tracer for studying the fate of these metals and organic carbon in estuarine environments. The inhomogeneity of the concentrations and inventories of the different elements along a 10-km segment of a river suggests that a closely spaced sampling program is essential for characterizing the sedimentary provinces within an estuary. The concentrations of Cs-137, metals, and organic carbon in the coarse-grained sediments (i.e., >63 um) are considerably lower than those in fine-grained sediments. Thus, the contribution of coarse-grained sediments to the total inventory of these elements is small. References (43 items).

Yarbro, L. A., et al. 1983. "A Sediment Budget for the Choptank River Estuary in Maryland, U.S.A.," Estuarine Coastal and Shelf Science, 17(4):555-570.

A sediment budget for the Choptank River, one of the three largest estuaries on the eastern shore of Chesapeake Bay, was developed from measurements of sediment carried in upland runoff, shore erosion, sedimentation, and levels of suspended sediments in estuarine waters. Shore erosion was the major source of sediment (340×10^6 kg year⁻¹), contributing seven times more sediment than upland runoff. Low relief, the rural character of the Coastal Plain drainage basin, and the susceptibility of poorly consolidated shoreline materials to erosion contributed to the dominance of shore erosion over runoff as a sediment source. Box modelling indicated a net annual flux (14-44 × 10⁶ kg year⁻¹) of sediment from the Choptank River to Chesapeake Bay. A mass balance estimate of sedimentation, calculated as the difference between total inputs and loss at the mouth of the estuary (50 × 10⁶ kg year⁻¹), agreed well with an estimate based on ²¹⁰Pb profiles (34 × 10⁶ kg year⁻¹) measured along the longitudinal axis of the estuary. Lead-210 sedimentation rates corresponding to accumulation rates of 1.5-7.4 mm year⁻¹ reflect the... (26 items).

Youakim, S., and Reiswig, H. M. 1984. "The
Distribution and Flux of Particulate Mat-
ter in the Bideford River Estuary, Prince
Edward Island, Canada," Estuarine, Coastal
and Shelf Science, 18(5):511-525.

The temporal and spatial distribution of
total and organic particulate matter is
investigated in the Bideford River estu-
ary. Particulate matter is homogenously
distributed in both the water column and
the surface sediment, due to high rates of
resuspension and lateral transport. The
measured mean sedimentation rate for the
estuary is 183.5 g of particulate matter
m^{-2} day^{-1}, of which more than half is due
to resuspension. The surface sediment of
the estuary is quantitatively the dominant
reservoir of organic matter, with an
average of 902.5 g of particulate organic
carbon (POC) m^{-2} and 119.5 g of parti-
culate organic nitrogen (PON) m^{-2}. Per
unit surface area, the sediment contains
450 times more POC and 400 times more PON
than the water column. Terrestrial ero-
sion contributes high levels of particu-
late matter, both organic and inorganic,
to the estuary from the surrounding water-
shed. Low rates of sediment export from
the estuary result in the accumulation of
the terrigenous material. The allochthon-
ous input of terrigenous organic matter
masks any relationship between the indige-
nous plant biomass and the organic matter.
In the water column, a direct correlation
exists between the organic matter, i.e.,
POC and PON, concentration and the phyto-
plankton biomass as measured by the plant
pigments. Resuspension is responsible for
the residual organic matter in the water
column unaccounted for by the phytoplank-
ton biomass. The particulate content of
the water column and the surface sediment
of the estuary is compared to that of the
adjacent bay. Water-borne particulate
matter is exported from the estuary to the
bay, so that no significant differences in
concentration are noted. The estuarine
sediment, however, is five to six times
richer in organic and silt-clay content
than the bay sediment. Since sediment
flux out of the estuary is restricted, the
allochthonous contribution of terrigenous
particulate matter to the bay sediment is
minor, and the organic content of the bay
sediment is directly correlated to the
autochthonous plant biomass. References
(26 items).

SECTION III. SALINITY EFFECTS

Saltwater intrusion, locks separating bodies of fresh and salt water, salinity currents, saltwater barriers, and contamination by salt water as distinguished from contamination from other sources.

Abbott, M. B., Schrøder, H., and Warren, I. R. "Modelling of the Salinity Intrusion in the Sound Between Denmark and Sweden." (See complete entry in Section VI.)

Abraham, G. "On Internally Generated Estuarine Turbulence." (See complete entry in Section I.)

Anwar, H. O. 1980. "Measurements on Entrainment Through a Front," Proceedings, Second International Symposium on Stratified Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:143-153.

The flow of a freshwater front over a saltwater mass at rest was produced when a partition, dividing these two fluids, was raised quickly. The moving layer was steady and was separated from the salt water by a stable interface. This type of flow can occur at the mouth of an estuary when high freshwater flow predominates over tidal flow. A study was made on the flow structure and the entrainment process of an advancing freshwater front flowing two-dimensionally over a pool of salt water. The leading front was wedge shaped with a pointed tip. At a certain distance from the tip, there was a rapid growth in the layer thickness associated with an increase in saltwater concentration, mainly due to the development of a highly turbulent flow having a large-scale structure. In this region a large amount of the underlying salt water was entrained across the interface. The turbulence intensity of salt water and of velocity fluctuation was large. Beyond this region the large-scale structure fragmented; the turbulence was no longer active, with very little, if any, entrainment. The density and the velocity profiles in the active and nonactive turbulent regions were self-similar. The coefficient of entrainment decreases rapidly as the Richardson number rises. References (6 items).

Anwar, H. O. "Turbulence Measurements in Stratified and Well-Mixed Estuarine Flows." (See complete entry in Section I.)

Anwar, H. O., and Weller, J. A. 1981. "An Experimental Study of the Structure of a Freshwater-Saltwater Interfacial Mixing," La Houille Blanche, 36(6):405-412.

This paper describes the results of an experimental study of fresh water which flows two-dimensionally over a still pool of salt water. This type of flow can be observed when heated cooling water is discharged from a power station horizontally onto the surface of a lake or reservoir, or in an estuary where the outflow of fresh water mixes with underlying salt water; the flux of brackish water increases with the distance downstream from the head of the estuary. In these types of flow, the depth of the lighter fluid at the mouth is usually high, being of the order of 2-3 m; and the mouth densimetric Froude number (defined later) is about unity or less, indicating that the mixing process of the surface layer is dominated mainly by buoyancy rather than momentum. In most previous laboratory studies, measurements were carried out for jet-type flow, for which the densimetric Froude number was high with a shallow depth of flow at the inlet. The object of the present investigation is to study the cases in which the densimetric Froude number is low, varying between 0.5 and 2, and the depths of fresh water, which are relatively large, vary between 0.08 m and 0.12 m. It is assumed that the flow structure and the turbulent mixing process that occur in this study are similar to those occurring in nature. Experimentally fresh water was released two-dimensionally from a wide channel onto the surface of stationary salt water with density of 1,025 kg/m³ held in a wide, deep flume. During the experimental runs, salt water was supplied gently at a constant rate along the bottom of the flume in order to obtain a steady surface flow. Mean velocity and density profiles, together with their turbulence intensities, were measured at various sections downstream from the inlet. Entrainment was measured directly from saltwater supply, and it was also determined from density profiles. References (37 items).

Boyden, C. R., Aston, S. R., and Thornton, I. "Tidal and Seasonal Variations of Trace Elements in Two Cornish Estuaries." (See complete entry in Section II.)

Breusers, H. N. C., and van Os, A. G. "Physical Modelling of the Rotterdamse Waterweg Estuary." (See complete entry in Section VI.)

Brown, W. D., and Arellano, E. "The Application of a Segmented Tidal Mixing Model to the Great Bay Estuary, N.H." (See complete entry in Section VI.)

Chu, W.-S., and Willis, R. "Mathematical Modeling of Humboldt Bay." (See complete entry in Section VI.)

Chu, W.-S., and Yeh, W. W-G. "Parameter Identification in Estuarine Modeling." (See complete entry in Section VI.)

Chu, W.-S., Yeh, W. W-G., and Kristof, R. C. "Mathematical Modeling and Parameter Identification in a Two-Dimensional Estuary: Case Study of the Hydraulic Model of the San Francisco Bay and Delta." (See complete entry in Section VI.)

Coastal Sediments '77, Fifth Symposium of
    the Waterway, Port, Coastal and Ocean
    Division of ASCE. (See complete entry in
    Section II.)

Connell, D. W., et al. "Effects of a Bar-
    rage on Flushing and Water Quality in the
    Fitzroy River Estuary, Queensland." (See
    complete entry in Section V.)

Crout, R. L., and Murray, S. P. "Shelf and
    Coastal Boundary Layer Currents, Miskito
    Bank of Nicaragua." (See complete entry
    in Section VIII.)

Dandy, G. C., Mills, D. A., and Hinwood,
    J. B. "Water Movement Studies Required
    for Port Planning." (See complete entry
    in Section I.)

Devine, M. "Some Features of the Dynamic
    Structure of a Deep Estuary." (See com-
    plete entry in Section VI.)

Drapeau, G., and Fortin, G. "Tidal Sedimen-
    tation in Gros-Cacouna Harbor." (See com-
    plete entry in Section II.)

Dyer, K. R. 1982. "Mixing Caused by Lat-
    eral Internal Seiching Within a Partially
    Mixed Estuary," Estuarine, Coastal and
    Shelf Science, 15(4):443-457.

    The salinity fluctuations at an STD near
    the halocline in Southampton Water have
    been spectrally analyzed. Mixing is shown
    to commence at a layer Richardson number
    of about 20. The predominant energy in-
    puts have periods of 7-9 and 3.5-4.5 min.
    These motions arise from lateral internal
    seiching and it is considered that they
    are produced by interaction of the surface
    seiche with the shallow side of the estu-
    ary. The wavelengths of the standing wave
    are calculated to be about 120 and 60 m,
    respectively, and these compare well with
    echo-sounding surveys of the elevation of
    the halocline. References (22 items).

Dyer, K. R. "The Mixing Processes in a Par-
    tially Mixed Estuary: Southampton Water."
    (See complete entry in Section VII.)

Edinger, J. E., and Buchak, E. M. "Estua-
    rine Laterally Averaged Numerical Dynam-
    ics: The Development and Testing of Estu-
    arine Boundary Conditions in the LARM
    Code." (See complete entry in Sec-
    tion VI.)

Fiadeiro, P. M. "Study of Water Quality in
    the Tagus Estuary." (See complete entry
    in Section I.)

Fischer, H. B., et al. Mixing in Inland and
    Coastal Waters. (See complete entry in
    Section I.)

Fischer, K. "Numerical Salinity Intrusion
    Models." (See complete entry in Sec-
    tion VI.)

Fischer, K. "Numerical Tidal-Salinity
    Models of the Ems Estuary." (See complete
    entry in Section VI.)

Gardner, G. B., and Smith, J. D. "Observa-
    tions of Time-Dependent, Stratified Shear
    Flow in a Small Salt-Wedge Estuary." (See
    complete entry in Section I.)

Garofalo, D. 1980. "The Influence of Wet-
    land Vegetation on Tidal Stream Channel
    Migration and Morphology," Estuaries,
    3(4):258-270.

    Average relative stream channel migration
    rates of 0.21 m per year (0.72 ft per
    year) for saline tidal wetland stream
    channels, and 0.32 m per year (1.04 ft per
    year) for freshwater tidal wetland chan-
    nels were calculated for a 32-year period
    (1940 to 1972) using photogrammetric tech-
    niques. Saline wetland stream channels
    averaged higher indices of sinuosity,
    i.e., the ratio of total channel length to
    linear downstream distance (1.95), when
    compared with sinuosities of freshwater
    tidal channels (1.46). The difference is
    attributed to differences in vegetation
    types and consequent soil holding capacity
    between saline and freshwater tidal wet-
    land environments. Saline channels become
    entrenched because the banks are supported
    by dense root systems, while freshwater
    tidal channels flow through a more homo-
    genous substrate and behave much like
    channels which cross mudflats in the
    intertidal zone. Higher average meander
    amplitudes (one-half the peak to trough
    distance of a given meander wave) for
    saline channels (171 m) versus lower
    amplitudes for freshwater channels (114 m)
    suggest that meander loops for saline
    channels are determined primarily by the
    erosional characteristics of streambanks
    and by other local factors rather than by
    hydrodynamic factors such as flow velocity
    or discharge. It has been stated that
    meander migration features do not occur in
    homogenous soil materials (Leopold, et
    al., 1964); the tendency of saline chan-
    nels to form these features is attributed
    to differential erosion caused by varia-
    tions in root system density. Conversely,
    the morphology of freshwater tidal chan-
    nels is influenced by hydrodynamic factors
    including discharge, and is due to the
    existence of more homogenous materials,
    i.e., muddy soils devoid of extensive root
    systems. An analysis of ebb and flood
    discharge data arrived at for each tidal
    channel using existing tidal current
    velocity and upland discharge records
    supports the fact that relatively greater
    erosive forces occur in salt marsh than in
    fresh tidal marsh areas. A poor

statistical correlation between rates of stream channel migration and hydraulic stream flow data such as velocity and discharge must be accepted with caution due to the method of approximating tidal discharge values. The correlation suggests that under normal tidal conditions both saline and freshwater tidal channels migrate little, if any, and thus represent an apparently balanced relatively low energy system. For this reason it is believed that most stream channel migration in both saline and freshwater wetlands occurs as a result of increased forces due to storms. References (17 items).

Garvine, R. W. 1977. "River Plumes and Estuary Fronts," Estuaries, Geophysics, and the Environment, National Academy of Sciences, Washington, D.C., 30-35.

The manner in which fresh water flows down to the sea and mixes with it is one that varies greatly in nature. The extremes of the possibilities are marked, on the one hand, by a wide estuary where sea water moves inland well upstream of the mouth to meet the fresh water and, on the other hand, by a river whose lower valley is narrow, which confines its discharge so that the fresh water is forced out at its mouth to mix with salt water only off-shore. This latter condition, in which a distinct plume of brackish water is produced beyond the mouth, is the principal concern of this paper. References (10 items).

Gibbs, R. J. "Currents on the Shelf of North-eastern South America." (See complete entry in Section I.)

Gibbs, R. J. "Suspended Sediment Transport and the Turbidity Maximum." (See complete entry in Section II.)

Grabemann, I., Krause, G., and Siedler, G. 1983. "Long-Time Changes of Salinity in the Lower Weser" ("Langzeitige Änderung des Salzgehaltes in der Unterweser"), Deutsche Hydrographische Zeitschrift, 36(2):61-77 (In German).

Ever since construction has altered the estuary of the Weser River to make it more navigable, regular water samples have been collected at several stations along the river. Salinities were determined in order to assess possible changes as a consequence of the engineering activities. For almost 100 years the sampling scheme remained unaltered. Today this unique data set is of more than local interest. Whereas drastic changes of tidal phenomena are obvious from tidal gage measurements, natural fluctuations of salinity hide respective changes of the salinity distribution. An attempt has been made to separate the natural from the man-made fluctuation of salinity using two simple models to eliminate known causes of natural fluctuations. Difficulties encountered were the incompleteness of the data set and the absence of data averaged over cross sections. Nevertheless it was possible to eliminate, approximately, the influence of the catchment area and salinity variations of the adjacent sea. Salinity variations as a consequence of the engineering works depend on the quantity $K = H^2/(\bar{A} \cdot \zeta_0)$, where H is the depth of a cross section with area $\bar{A}$ averaged over the tides, and $2\zeta_0$ is the tidal elevation. Because of long-term changes of the tides in the North Sea, it was not possible to isolate the influence of the engineering works. Conclusions include consequences for modern sampling strategies to determine trends of water quality. References (25 items).

Granat, M. A., and Gulbrandsen, L. F. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)

Hamilton, A. D. "Nontidal Circulation and Mixing Processes in the Lower Potomac Estuary." (See complete entry in Section I.)

Hamilton, P. "Survey of Marine Wetland and Estuarine Water Quality and Ecological Problems in Corps of Engineers Field Offices." (See complete entry in Section V.)

Hamrick, J. M. 1981. "Baroclinic Circulation and Dispersion in Estuaries," Proceedings, Specialty Conference, Water Forum '81, San Francisco, Calif., August 10-14, 1981, ASCE, I:383-390.

The equations governing residual baroclinic circulation in partially stratified estuaries are derived and scaled for perturbation solution. A one-dimensional tidal cycle averaged mass transport equation is developed to close the baroclinic circulation solutions. In the one-dimensional mass transport equation the longitudinal dispersion coefficient is decomposed into baroclinic and tidal driven or barotropic components. Relationships are given for calculating the dispersion coefficients, and applications of the mass transport equation for salinity intrusion and pollutant dispersion analyses are discussed. References (8 items).

Harper-Owes. "Duwamish Waterways Navigation Improvement Study: Analysis of Impacts on Water Quality and Salt Wedge Characteristics." (See complete entry in Section IV.)

Heathershaw, A. D., and Hammond, F. D. C.
"Swansea Bay (SKER) Project, Topic
Report 4; Tidal Currents: Observed Tidal
and Residual Circulations and Their
Response to Meteorological Conditions."
(See complete entry in Section I.)

Hickel, W. 1980. "The Influence of Elbe
River Water on the Wadden Sea of Sylt
(German Bight, North Sea)," Deutsche
Hydrographische Zeitschrift, 33(4):43-52.

The transportation period of Elbe River
water, admixed with the North Frisian
coastal water, from the estuary to the
outer Wadden Sea of Sylt was investigated
using Elbe River floods (January 1975).
The time difference between maximum salin-
ity decrease at light-vessel "Elbe 1" off
the Elbe estuary and that off List (Wadden
Sea of Sylt) is 1 month. This is equiva-
lent to a mean residual current velocity
of 4.8 cm/sec, under the condition of
winds from south-southwest with an average
speed of 10.8 m/sec, and assuming that the
Elbe water travels the shortest way north.
Taking this transportation period into
consideration, the quantitative relation-
ship between the salinity off List (Y)
(from 3 years' measurements) and both Elbe
water discharge volumes (X_1) (of the pre-
vious month) and local freshwater surplus
(X_2) was calculated. It could be shown
that the multiple linear regression func-
tion $Y = a + b_1X_1 + b_2X_2$ describes the
relationship optimally (multiple and par-
tial correlation coefficients significant
at the 0.1 percent level). The partial
regression coefficient b_2 of this equa-
tion is by one order of magnitude higher
than b_1 ; 10 m³/sec of local freshwater
surplus would decrease the salinity off
List to 0.2443‰ , whereas 10 m³/sec of
Elbe water would decrease it to 0.0275‰.
Without the influence of these freshwater
sources a mean salinity of 31.92‰ would
be found off List. Since the Elbe River
discharged 52 times more fresh water
during the investigation period than the
local freshwater input (26 times more in
winter, November to April), the Elbe water
would decrease the salinity in the Wadden
Sea of Sylt sixfold more in absolute terms
(threefold more in winter) than the local
freshwater surplus. This dominant influ-
ence of the Elbe water on the Wadden Sea
of Sylt, situated 130 km north of the Elbe
estuary, must have considerable ecological
significance, since dissolved and finely
suspended particulate matter from the Elbe
River (at least the "conservative" compon-
ents) will be carried to the Wadden Sea of
Sylt at the same rate as follows from the
calculations using salinity. References
(10 items).

Hinwood, J. B., and Colman, R. S. "Use of
an Echo Sounder to Map Vertical

Stratification in an Estuary." (See
complete entry in Section VII.)

Hunkins, K. 1981. "Salt Dispersion in the
Hudson Estuary," Journal of Physical
Oceanography, 11(5):729-738.

The seaward transport of salt by river
discharge through an estuary is balanced
under steady conditions by landward dis-·
persion effected by various physical mix-
ing processes. Observations of current
and salinity in the lower Hudson estuary
provide a basis for assessing the relative
importance of these different dispersion
processes. Wind effects were estimated
from two moored current meter records of
1- and 2-month length. There was a sig-
nificant but weak correlation between wind
and currents. Three cross-sectional
surveys each lasting 25 hr provide esti-
mates of salt dispersion by other pro-
cesses. Current and salinity data from
the surveys were decomposed into various
temporal and spatial means and departures
from these means. Covariances between the
various quantities are interpreted in
terms of physical dispersion processes.
The largest contributor to salt dispersion
in the Hudson is the steady shear of grav-
itational circulation. Steady shear dis-
persion varies by a factor of 5 between
spring high-flow and summer low-flow con-
ditions. Dispersion by tidally varying
shear was much lower in magnitude. Corre-
lation between sectionally averaged cur-
rent and salinity yields a paradoxical
negative dispersion which can be explained
in terms of two documented estuary charac-
teristics, the tendency of bottom tidal
currents to lead upper layer currents in
phase and the increased longitudinal sa-
linity gradient near the surface. Refer-
ences (16 items).

Hutchison, I. P. G., and Midgley, D. C.
"Mathematical Modelling of Water Level and
Salinity Regimes in Some South African
Lake and Estuary Systems." (See complete
entry in Section VI.)

Huzzey, L. M. "The Dynamics of a Bathymet-
rically Arrested Estuarine Front." (See
complete entry in Section I.)

Kawahara, M. "Periodic Finite Elements in
Two-Layer Tidal Flow." (See complete
entry in Section I.)

Kawahara, M., and Hasegawa, K. "Finite Ele-
ment Analysis of Two-Layered Tidal Flow."
(See complete entry in Section VI.)

Kendrick, M. P., and Derbyshire, B. V.
"Effects of a Barrier on Existing Estuary
Regime." (See complete entry in
Section V.)

Khorram, S. "Remote Sensing of Salinity in
the San Francisco Bay Delta." (See com-
plete entry in Section VII.)

Kjerfve, B., ed. Estuarine Transport Pro-
cesses. (See complete entry in Sec-
tion II.)

Krause, G. 1980. "Separation of Climatic
Fluctuations and Impacts of Engineering
Activities in Estuaries," Proceedings,
Seventeenth Coastal Engineering Confer-
ence, March 23-28, 1980, Sydney, Aus-
tralia, ASCE, III:2325-2339.

Using salinity as an example of dissolved
substances in estuarine waters, it is
shown how the long-term trend of concen-
trations can be split up into a man-made
and a climatic contribution. The under-
standing of long-term mixing processes and
adequate sampling techniques is essential
for this purpose. The physical state of
the estuary can be described in terms of
three basic variables: the river dis-
charge, the filtered water level, and the
filtered salinity. The river discharge
represents the climatic fluctuations in
the catchment area, and the filtered water
level is a record of the large-scale wea-
ther pattern over the adjacent ocean
basin. Salinity trends which cannot be
attributed to these two variables must
originate from man-made actions, such as
dredging or other engineering activities
which change the geometry of an estuary.
Two models are used for the trend analy-
sis: the simplest possible mixing equa-
tion, which always holds for a suffi-
ciently long time scale, and a salt flux
consideration. References (5 items).

Kuo, C. Y., and Blair, C. H. "Comparison of
Verified Physical and Mathematical Model."
(See complete entry in Section VI.)

Lentsch, J. W., et al. "Stable Manganese
and Manganese-54 Distributions in the
Physical and Biological Components of the
Hudson River Estuary." (See complete
entry in Section IV.)

Lepetit, J. P., and Davesne, M. "Dynamics
of Silt in Estuary, Residual Current or
Flocculation Which Prevails?" (See com-
plete entry in Section II.)

Lewis, R. E., and Lewis, J. O. 1983. "The
Principal Factors Contributing to the Flux
of Salt in a Narrow, Partially Stratified
Estuary," Estuarine, Coastal and Shelf
Science, 16(6):599-626.

Observations of the velocity and salinity
structure of the Tees estuary were made at
eight stations along the estuary axis be-
tween Victoria Bridge and the sea during
the summer of 1975. The measurements were
made on ten separate tidal periods cover-
ing neap and spring tides. The data were
collected over a period of relatively low
freshwater flows and the residual current
was found to have a strong dependence on
the Stokes drift. At the upstream sta-
tions, the residuals were more than an
order of magnitude greater than the cur-
rents anticipated from the freshwater dis-
charge. Although the mean stratification
decreased as the tidal range increased,
the vertical circulation was stronger on
spring tides than on neaps. Vertical
variations in the amplitude and phase of
the tidal current result in a current
which strengthens the vertical circula-
tion. However, this effect only made a
relatively small contribution to the
observed vertical circulation. The
relative contribution of the individual
salt flux terms to the net upstream
transport of salt varies along the estu-
ary. As the estuary narrows, the con-
tribution by the oscillatory terms domi-
nates that from the shear in the steady
state flow. Of these oscillatory terms,
the correlation of velocity and salinity
fluctuations plays a key role in the salt
transport. The depth mean values make a
greater contribution than deviations from
the depth mean, and the flux due to phase
variations over depth is smaller than
either of these. Since the Stokes drift
is compensated by a downstream steady
state flow, it does not contribute to the
tidal mean transport of salt. At the
seaward end of the estuary, the salt
fluxes due to the steady state vertical
shear and the covariance of the tidal
fluctuations act in a complementary way to
counter the seaward transport of salt by
the freshwater flow. With the possible
exceptions of the wide or narrow reaches
of the Tees, the longitudinal fluxes of
salt due to transverse variations in
velocity, salinity and depth and turbulent
fluctuations are of secondary importance
as contributors to the estuary salt
budget. On both neap and spring tides,
the computed total salt transports at the
Newport and Victoria bridges did not match
the values required for a salt balance
with the corresponding freshwater flows.
These fluxes were probably the cause of
the observed downstream displacement of
the tidal mean salinity distribution
between neap and spring tides. References
(23 items).

Lin, P., Dai, Z., and Li, K. "Unsteady Flow
Studies in China." (See complete entry in
Section I.)

Liu, S. K., and Leendertse, J. J. "Three-
Dimensional SGC Energy Model of Eastern
Bering Sea." (See complete entry in Sec-
tion VI.)

Lundgren, H. "Struggle of Physics and Math-
ematics." (See complete entry in
Section I.)

McAnally, W. H., Jr., Brogdon, N. J., Jr.,
and Stewart, J. P. "Columbia River Estu-
ary Hybrid Model Studies; Report 4,
Entrance Channel Tests." (See complete
entry in Section VI.)

Mangarella, P. A., and Robilliard, G. A.
"Thermal and Biological Impact of LNG
Vaporizer Discharge." (See complete entry
in Section V.)

Marche, C. 1978. "Stability Study of an
Artificial Salt Intrusion in Estuaries,"
Proceedings, Sixteenth Coastal Engineering
Conference, August 27-September 3, 1978,
Hamburg, Germany, ASCE, III:2798-2809.

The stratification and salinity structure
of the water mass in the lower portions of
tidal estuaries are important factors of
the general circulation and local water
quality. In natural conditions an equi-
librium can be observed in each estuary
and depends on the geometry of the estu-
ary, the motion of tides inside the estu-
ary, and the freshwater discharge. Exten-
sive studies of the salinity structure in
the estuaries of the La Grande and Grande
Baleine rivers have shown that water of
high salinity content will be expected
along the total length of the estuary, for
the discharge expected during the fill-up
period. Sandbars being present in several
transverse sections in these estuaries, it
is of the greatest importance to verify if
the salt water introduced upstream of
these bars by a provisional modification
in the freshwater discharge would not be
definitely present. This paper presents
the relevant parameters, the theoretical
formulation, and the results obtained for
the above-mentioned estuaries. References
(3 items).

Marche, C., et al. 1978. "A Study of the
Influence of River Discharge Regulation on
the Salinity Equilibrium in the Estuary,"
Proceedings, International Conference on
Water Resources Engineering, Asian Insti-
tute of Technology, Bangkok, Thailand,
January 10-13, 1978, I:219-231.

The salinity structure and the stratifica-
tion of the water mass of an estuary are
analyzed under natural and modified river
conditions. The different steps of this
analysis are explained. Special attention
is given to the data required for the
practical application of the different
methods used. As an example, results of
such an analysis are presented for the
La Grande River. This river will be the
site of a hydroelectric development which
will modify completely the freshwater flow
in the lowest part of the river.

Matsunaga, K., et al. 1984. "Behavior of
Organically-Bound Iron in Seawater of
Estuaries," Estuarine, Coastal and Shelf
Science, 18:615-622.

Behaviors of organically-bound iron in an
estuary having normal primary production
and in a red tide outbreak estuary were
investigated. In the former, the iron
complex decreases with increasing salinity
because of its flocculation. In the
latter, the iron complex, as well as nu-
trients except silicate, is completely
assimilated by phytoplankton. Among nu-
trients, silicate diffuses by only water
mixing because the main species of phyto-
plankton were green colored algae at the
river mouth. High nitrite concentration
was found at about 15‰ salinity. This
means that the decomposition of phyto-
plankton as well as photosynthesis is also
carried out. The iron complex assimilated
would be released to seawater with the
decomposition of phytoplankton, and then
red tide outbreaks at the estuary would be
continued for a long period. References
(19 items).

Milford, S. N., and Church, J. A. "Simpli-
fied Circulation and Mixing Models of
Moreton Bay, Queensland." (See complete
entry in Section VI.)

Muench, R. D., and Coachman, L. K. "Energy
Balance in a Highly Stratified Embayment:
Norton Sound, Alaska." (See complete
entry in Section I.)

Muir, L. R. "Internal Tides in a Partially-
Mixed Estuary." (See complete entry in
Section I.)

Muralikrishna, I. V., and Devanathan, R.
"Circulation and Salinity Distribution in
Coastal Inlets." (See complete entry in
Section VI.)

Najarian, T. O., Wang, D-P., and Huang, P-S.
"Lagrangian Transport Model for Estu-
aries." (See complete entry in Sec-
tion VI.)

Nece, R. E., and Scheffner, N. W. "Field
Data Analysis for Chesapeake Bay Model
Verification." (See complete entry in
Section VIII.)

Novak, P., and Čábelka, J. Models in Hy-
draulic Engineering; Physical Principles
and Design Applications. (See complete
entry in Section VI.)

O'Connor, D. J., and Lung, W. "Suspended
Solids Analysis of Estuarine Systems."
(See complete entry in Section VI.)

Odd, N. V. M. "Significance of Long-Period
Tidal Oscillations in Estuaries." (See
complete entry in Section I.)

Odd, N. V. M., and Baxter, T. "Port of
Brisbane Siltation Study." (See complete
entry in Section VI.)

Odgaard, J. "Salt Exchange by Salt Fingers." (See complete entry in Section VI.)

Officer, C. B., and Lynch, D. R. 1981. "Dynamics of Mixing in Estuaries," Estuarine, Coastal and Shelf Science, 12(5):525-533.

The one-dimensional, advective-dispersive equation for a nonconservative substance is reformulated such that salinity replaces longitudinal distance as one of the independent variables. This general formulation is used to discuss the concept of concentrate-salinity mixing curves. The importance of temporal variations and loss terms in distorting these curves is illustrated by solving the transformed equation for simple cases. Procedures for measurement, interpretation, and prediction of mixing curves are discussed. References (6 items).

Ozturk, Y. F. "Mathematical Modeling of Dispersion in Mixed Estuaries." (See complete entry in Section VI.)

Pape, E. H., III, and Garvine, R. W. "The Subtidal Circulation in Delaware Bay and Adjacent Shelf Waters." (See complete entry in Section VI.)

Partch, E. N., and Smith, J. D. 1978. "Time Dependent Mixing in a Salt Wedge Estuary," Estuarine and Coastal Marine Science, 6(1):3-19.

Measurements of the profiles of salinity and velocity at a station in the Duwamish River estuary indicate that the turbulent mixing through the density interface is highly time dependent with the most intense mixing occurring at the maximum current speed during the ebb. Additional measurements of the turbulent kinetic energy and the turbulent flux of salt by the eddy correlation technique verify that interpretation. The vertical turbulent salt flux and the turbulent kinetic energy vary by an order of magnitude over the tidal cycle, and approximately half of the total vertical salt transport takes place during a short time centered about the maximum ebb. Different mechanisms of turbulence generation operate at various times during the tidal cycle, and the intense mixing periods are shown to coincide with conditions favorable for the formation of an internal hydraulic jump. References (15 items).

Partheniades, E., Dermisis, V., and Mehta, A. J. 1980. "Graphs for Saline Wedges in Estuaries," Civil Engineering, 50(1):90-92.

This paper presents an approach for predicting the shape of and change in the longitudinal extent of saltwater intrusion in a stratified estuary for specified geometries for those concerned with the effects of altering the flows of an estuary, such as by dredging. References (4 items).

Pickrill, R. A., Irwin, J., Shakespeare, B. S. "Circulation and Sedimentation in a Tidal-Influenced Fjord Lake: Lake McKerrow, New Zealand." (See complete entry in Section II.)

Pitblado, R. M., and Prince, R. G. H. 1977. "The Application of a Two-Layer Time-Dependent Model to Pollution Assessment and Control in a Short Stratified Estuary," Progress in Water Technology, Eighth International Conference on Water Pollution Research, 17-22 October 1976, Sydney, Australia, 9(1):217-231.

The estuary and its tributaries are segmented into 22 sections, each section being composed of two perfectly mixed boxes representing the upper and lower layers. Salinity biochemical oxygen demand (BOD), and dissolved oxygen (DO) are predicted in every box each 20 min following closely the variations due to tidal flow. Comparisons between two experimental runs and predictions are given. An important use of the model is to predict transient pollution levels in the estuary after a major storm. A simulation of such a storm is included and the bulk movement of pollution seawards and from the upper and lower layer is clearly demonstrated. Several applications of the model to pollution control and enforcement are outlined, including the identification of polluting sources and loads and the design and interpretation of sampling schemes. Both one-dimensional and two-layer models are discussed. The experimental procedure requires salinity, BOD, and DO to be determined at five representative locations and at two depths. All significant freshwater inputs in the upper river are measured as well as the seawards boundary conditions. The present model is limited in that it only predicts salinity, BOD, and DO. The two-layer model contains a considered balance between the hydraulic and pollution descriptive components. An advantage of this simple hydraulic description is that a relatively simple computer model results. The model may be used for several specific applications including abatement planning schemes for those estuaries subject to transient loads, organization of effective sampling programs and interpretation of resulting data, and identification of nature and location of pollutant discharges. References (17 items).

Richards, D. R., and Sutherland .
"Low Freshwater Inflow ...

Bay Hydraulic Model Investigation." (See
complete entry in Section VI.)

Richards, D. R., and Morton, M. R. "Norfolk
Harbor and Channels Deepening Study; Re-
port 1, Physical Model Results; Chesapeake
Bay Hydraulic Model Investigation." (See
complete entry in Section VI.)

Robinson, I. S. "A Tidal Flushing Model of
the Fleet--An English Tidal Lagoon." (See
complete entry in Section VI.)

Rodger, J. G. "Simulation of Stratified
Flows in Estuaries." (See complete entry
in Section III.)

Scheffner, N. W., et al. "Verification of
the Chesapeake Bay Model; Chesapeake Bay
Hydraulic Model Investigation." (See com-
plete entry in Section VI.)

Schwing, F. B., and Kjerfve, B. "Longitu-
dinal Characterization of a Tidal Marsh
Creek Separating Two Hydrographically Dis-
tinct Estuaries." (See complete entry in
Section I.)

Continental Shelf." (See complete entry
in Section I.)

Simpson, J. H., and Nunes, R. A. "The Tidal
Intrusion Front: An Estuarine Convergence
Zone." (See complete entry in Section I.)

Smith, R. 1978. "Effect of Salt Upon Hot-
Water Dispersion in Well-Mixed Estuaries,"
Estuarine and Coastal Marine Science,
7(5):445-454.

Temperature and salinity variations both
give rise to buoyancy-driven currents.
Thus, when hot water is discharged into
estuaries, the flow is changed both by the
heat and by the induced perturbation of
the salinity distribution. If cross-
sectional mixing takes place in much less
than the tidal period, then it can be
shown that the salinity anomaly and the
temperature distribution satisfy coupled
nonlinear diffusion equations. For weak
buoyancy effects, the interactions are
such as to disperse heat preferentially
inland. Quantitative estimates suggest
that the asymmetry between inland and out-
to-sea dispersion coefficients can be as
much as 40 percent. References.

and such phenomena as the transitions of
mixing states and the movement of internal
vortex due to the tidal amplitude and
tidal variation are discussed. Some
considerations as the result of field in-
vestigation led to the determination of
the application range and boundary condi-
tions of the simulation model, supple-
menting important information and
accuracy. References (3 items).

Sündermann, J., and Holz, K.-P., ed. Mathe-
matical Modelling of Estuarine Physics,
Lecture Notes on Coastal and Estuarine
Studies. (See complete entry in
Section I.)

Thatcher, M. L., and Harleman, D. R. F.
"Long-Term Salinity Calculation in Dela-
ware Estuary." (See complete entry in
Section VI.)

Uncles, R. J. "Hydrodynamics of the Bristol
Channel." (See complete entry in Sec-
tion I.)

Uncles, R. J., and Jordan, M. B. 1979.
"Residual Fluxes of Water and Salt at Two
Stations in the Severn Estuary," Estuarine
and Coastal Marine Science, 9(3):287-302.

Observations of currents and salinity are
presented for two stations in the Severn
Estuary; the observations extend over
50-hr periods at both stations, and the
data are analyzed to provide estimates of
the residual fluxes of water and salt.
Relative to the depth-averaged values, the
axial residual currents show a seaward
flow in the upper layer, and a landward
flow in the bottom layer for both sta-
tions, the associated salinity profiles
show only small differences in salinity
between the seabed and the sea surface
. . . The tidally averaged velocity
and salinity profiles are used to estimate
the effective vertical eddy viscosity and
diffusivity which are applicable to resid-
ual variables; estimated maximum values
. . . of the order of . . . and . . . cm . . .
respectively. The computation of resid-
ual . . . shows that the fluxes . . . an
important feature . . . the physics . . . the
. . . Severn Estuary . . . the residual
transport of water . . . the bottom . . . the . . .
. . .

position in the Tamar Estuary undergoes
large seasonal variations. It is shown
that these variations are a consequence of
variable freshwater inputs to the estuary,
and that axial distributions of surface
salinity can be estimated with reasonable
accuracy from the freshwater inputs using
simple regression formulae. Flushing
times and axial dispersion coefficients
are computed for low runoff, spring tide
conditions, when the estuary approaches
the well-mixed state. The observed dis-
persion coefficients are compared with
those predicted from theoretical consider-
ations. Various shear dispersion mecha-
nisms are investigated, as well as those
due to tidal "random walk," and tidal
"trapping." The estimated cross-estuary
mixing due to tidal "random walk" is much
greater than that which can be attributed
to turbulence alone. Assuming this en-
hanced cross-estuary mixing, it is shown
that the observed dispersion in the upper
estuary can be attributed to transverse
oscillatory shear. Dispersion in the
lower estuary is more complex, and for low
runoff, spring tide conditions, the most
important individual process appears to be
tidal "trapping." References (27 items).

van de Kreeke, J., and Wang, J. D. "Tidal
Hydraulics and Salt Balance of Lake Worth,
Florida." (See complete entry in
Section VI.)

Vreugdenhil, C. B. "Application of Finite-
Difference Methods to Estuary Problems."
(See complete entry in Section I.)

Walters, R. A., and Cheng, R. T. "A Two-
Dimensional Hydrodynamic Model of a Tidal
Estuary." (See complete entry in
Section VI.)

Ward, L. G. "Hydrodynamics and Sediment
Transport in a Salt Marsh Tidal Channel."
(See complete entry in Section II.)

Welch, J. M., and Parker, B. B. "Circula-
tion and Hydrodynamics of the Lower Cape
Fear River, North Carolina." (See com-
plete entry in Section I.)

West, J. R., Knight, D. W., and Shiono, K.
"A Note on Flow Structure in the Great
Ouse Estuary." (See complete entry in
Section I.)

Winterwerp, J. C. 1983. "Decomposition of
the Mass Transport in Narrow Estuaries,"
Estuarine, Coastal and Shelf Science,
16(6):627-638.

The mass transport as measured in the Rot-
terdam Waterway Estuary and in the tidal
salinity flume of the Delft Hydraulics
Laboratory is analyzed to obtain insight
into the magnitude of the dispersive mass
transport in narrow estuaries. It is
found that the magnitude of the dispersive
mass transport in the real-time one-
dimensional advection-diffusion equation
varies considerably over the tidal cycle,
that the ratio between the magnitude of
the dispersive mass transport by the net
vertical circulation and by the vertical
oscillatory shear in the tidally averaged
one-dimensional advection-diffusion equa-
tion decreases when the degree of strati-
fication in the flume is decreased, and
that the dispersive mass transport in the
Rotterdam Waterway and in the tidal salin-
ity flume is affected significantly by the
mixing processes at sea near the estuary
mouth. References (14 items).

Wiseman, W. J., Jr. 1979. "Hypersaline
Bottom Water: Peard Bay, Alaska," Estu-
aries, 2(3):189-193. Also published as
Technical Report No. 292, Coastal Studies
Institute Center for Wetland Resources,
Louisiana State University, Baton Rouge,
La.

Hypersaline bottom conditions have been
observed in Peard Bay, Alaska. The water
appears to be renewed on an annual basis.
Although it does not seem to affect perma-
frost degradation rates in Peard Bay, sim-
ilar pools of water along the Beaufort Sea
coast could greatly increase the rates of
permafrost degradation. Order of magni-
tude estimates suggest that the hypersa-
line waters do not become anoxic. Refer-
ences (16 items).

Wood, W. E. 1977. "The Fate of Storm
Water and Stormwater Pollution in the
Parramatta Estuary, Sydney," Australian
Journal of Marine and Freshwater Research,
28:167-76.

The small drainage area of the Parramatta
River and the great imperviousness of the

over Sydney are responsible for strong
stratification phenomena in the upper Par-
ramatta River estuary following rainfalls.
A simple model is proposed for the fate of
storm water and its effects on the water
quality of the estuary. References
(15 items).

Wood, T. "Discrete-Time Modelling of Dis-
persion in Estuaries." (See complete
entry in Section VI.)

Yakuwa, I., Takahashi, S., and Ohtani, M.
1978. "Behaviors of the Salt Wedge and
the Salinity Distribution at Estuaries,"
Proceedings, Sixteenth Coastal Engineering
Conference, August 27-September 3, 1978,
Hamburg, Germany, ASCE, III:2746-2760.

The salt wedge has been observed by ultra-
sonic method at estuaries of the Ishikari,
Shiribetsu, and Rumoi Rivers in Hokkaido,
Japan. According to the records of the
longitudinal profile of the salt wedge,
behavior of the interface of salt and
fresh water is strongly influenced by con-
figurations of the watercourse and the
riverbed. Therefore, in this paper, a
distance from the front of the salt wedge
to the river mouth is divided into two or
three sections in accordance with behavior
of the interface, and the salinity distri-
bution in the upper layer is estimated in
each section. By solving the differential
equation of two-dimensional salinity dif-
fusion, the distribution is represented by
terms of flow velocity, diffusion coeffi-
cients, depth of the upper layer, and sa-
linity at the boundary where diffusion
coefficients are determined by comparing
evaluated longitudinal distribution of
surface salinity with observed ones. By
estimating the rate of salinity entrain-
ment into the upper layer, the entrainment
coefficient E at the interface is evalu-
ated as $E = 0.4 \cdot 10^{-5} - 0.8 \cdot 10^{-5}$ at
three estuaries. References (5 items).

Yarbro, L. A., et al. "A Sediment Budget
for the Choptank River Estuary in Mary-
land, U.S.A." (See complete entry in Sec-
tion II.)

Yoshida, S. 1980. "Mixing Mechanisms of
Density Current System at a River Mouth,"
Proceedings, Second International Sympo-
sium on Stratified Flows, The Norwegian
Institute of Technology, Trondheim, 24-
27 June 1980, Torkild Carstens and Thomas
McClimans, ed., 11:654-663.

This paper describes internal mixing mech-
anisms of fresh and water system at a
tidal river mouth where the fresh water
regurgitation effect upon salt water over-
flow and the mixing of saline waters
layer of fresh water the velocity distri-
bution is reversed.

interface due to SVB. Here, SVA and SVB
are named for the spiral vortices above
and beneath the interface, respectively.
SVC is equivalent to the K-H spiral of
which the center coincides with the inter-
face, and contributes only to offshore
internal mixing. As the tide range

becomes large, another spiral vortex (SVR)
which generates in the wake of the bed
roughness element has an important role
for the mixing. The investigation extends
also to external mixing mechanism as well
as theoretical bases on the growth of the
above spirals. References (13 items).

SECTION IV. CONTAMINATION

Contamination from sources such as industrial wastes or sewage, as distinguished from contamination by salt water

Aston, S. R., and Stanners, D. A. 1981.
"Americium in Intertidal Sediments from
the Coastal Environs of Windscale," Marine
Pollution Bulletin, 12(5):149-153.

The distribution of americium in surface
intertidal sediments from a coastal envi-
ronment near the Windscale nuclear fuel
reprocessing plant has been investigated.
The study includes data on the broad scale
distribution of ^{241}Am in Northwest Eng-
land, but focuses on the sediments of the
Ravenglass estuary 10 km south of Wind-
scale. The results indicate that ameri-
cium concentrations in the inner estuary
sediments are up to seven times higher
than those from the Irish Sea itself.
Americium distribution on silt banks is
rather constant on a small scale, but
varies considerably between adjacent silt
bank and salt marsh areas. References
(13 items).

Aston, S. R., and Stanners, D. A. 1982.
"Gamma Emitting Fission Products in Sur-
face Sediments of the Ravenglass Estuary,"
Marine Pollution Bulletin, 13(4):135-138.

The occurrence of some fission products
from the Sellafield (formerly Windscale)
nuclear fuel reprocessing facility has
been determined for surface sediments from
forty locations in the Ravenglass estuary,
Northwest England. The influence of the
silt-sized fraction in the sediments on
the geographic distribution of ^{137}Cs is
clearly important, and to a lesser extent
also influences the distributions of
^{106}Ru, ^{134}Cs + ^{95}Zr Nb and ^{144}Ce. The
data are compared with recently published
results reported by the Ministry of Agri-
culture, Fisheries and Food for a
monitoring site in this estuary. Refer-
ences (8 items)

Aston, S. R., and Stanners, D. A. 1982.
"The Transport to and Deposition of Ameri-
cium in Intertidal Sediments of the Raven-
glass Estuary and Its Relationship to Plu-
tonium," Environmental Pollution, Ser-
ies B1, 3():1-9

The distributions of ^{241}Am in four cores
of intertidal sediment from the Ravenglass
estuary near the Windscale nuclear fuel
reprocessing facility, northwest England,
are reported. Maximum ^{241}Am activities
up to 200 pCi/g   are found at depth
in the sediments, and this pattern of
accumulation is compared with known
discharges to the sea from Windscale. The
results indicate a slow transfer of ameri-
cium to the depositing sediments when the
sedimentation rates derived from two
independent methods are applied to the
cores. This feature is interpreted and
further confirmed by considerations of
plutonium americium activity ratios
The results of a number of studies from
Windscale to the sediments of northwest

This slow movement is consistent with
earlier theoretical and field data which
indicate that americium is rapidly removed
to sediments on release, and subsequently
transported with bed loads in the coastal
environment. References (10 items).

Aston, S. R., et al. 1981. "Plutonium
Occurrence and Phase Distribution in Sedi-
ments of the Wyre Estuary, Northwest
England," Marine Pollution Bulletin,
12(9):308-314.

The occurrence of plutonium isotopes
derived from the Windscale reprocessing
facility discharges and weapons test fall-
out in intertidal sediments of the Wyre
estuary, Northwest England, is reported.
Windscale plutonium appears to be slowly
transported to the estuary in association
with sedimentary material, and its distri-
bution in surface and buried sediments is
controlled by the variations in organic
matter content of the sediments and/or
their grain size characteristics. Results
from chemical leaching experiments suggest
that very little plutonium is ion ex-
changeable or in humic substances, but it
is in other organic and Fe Mn hydrous
oxide fractions of the sediments. Pluto-
nium shows a similar depositional behavior
to mercury, which enters the Wyre directly
in local industrial discharges.
References (15 items).

Baliga, B. R., and Hudspeth, R. T. 1981.
"Evaluation of Sand Waves in an Estuary,"
Journal, Hydraulics Division, ASCE,
107(HY2):161-178.

The Bella-Williamson rate of sediment
turnover-organic content of sediment (RSI-
OCS) dissection plane method integrates
relevant physical, chemical, and biologi-
cal analyses in order to estimate the
chronic impacts of dredging on estuarine
ecosystems. A spectral analysis by a
finite Fourier transform of estuarine sand
waves is presented which only requires a
spatial sand wave record that is rela-
tively easy to measure in contrast to
stochastic analyses which require both
spatial and temporal observations of sand
wave profiles. The total energy content
of equivalent, the statistical var-
iance of the spatial sand wave profile, and
the equilibrium state of the wave form
can be ascertained from relatively observa-
measures of the bottom of estuary. Refer-
ences (15 items)

Barnett, M. O., and ...
...
...
...

Journal, Environmental Engineering, ASCE, 109(1):17-35.

Using Kepone as the test compound, the relation of sediment suspension to fate of hydrophobic pollutants through adsorption is examined. Adsorption experiments show rapid attainment of an equilibrium condition that is a linear function of dissolved Kepone concentration and an inverse nonlinear function of adsorbing solids concentration. An apparatus creating a one-dimensional distribution of suspended sediment over a sediment bed is used to experimentally simulate an estuarine tidal cycle during which the transfer of Kepone from the bed to water column is examined. A mathematical model of the adsorption and sediment resuspension process is used to analyze the experimental results. Resuspension and the variation of adsorption equilibrium with solids concentration are shown to be significant to the transfer. Adsorption kinetics are not significant because of the rapid approach to equilibrium. References (23 items).

Devine, M. "Some Features of the Dynamic Structure of a Deep Estuary." (See complete entry in Section VI.)

Elsinger, R. J., and Moore, W. D. 1984. "^{226}Ra and ^{228}Ra in the Mixing Zones of the Pee Dee River-Winyah Bay, Yangtze River and Delaware Bay Estuaries," Estuarine, Coastal and Shelf Science. $18(6):601-613$.

^{226}Ra and ^{228}Ra have nonconservative excess concentrations in the mixing zones of the Pee Dee River-Winyah Bay estuary, the Yangtze River estuary, and the Delaware Bay estuary. Laboratory experiments, using Pee Dee River sediment, indicate desorption of ^{228}Ra to increase with increasing salinities up to 20 . In Winyah Bay, desorption from river-borne sediments could contribute almost all of the increases for both isotopes. Desorption adds only a portion of the excess

The measured in the Yangtze River and adjacent shelf waters and Delaware Bay. In the Yangtze River the mixing zone extends over a considerable portion of the adjacent Shelf where ^{228}Ra is added to the water column by diffusion from bottom sediments, which ^{228}Ra concentrations increase from [...] diffusion of [...] The from bottom sediments [...] Bay [...]

Fischer, H. B., et al. Mixing in Inland and Coastal Waters. (See complete entry in Section I.)

Göhren, H., and Christiansen, H. "Ecological Aspects of a Deep Water Port in the Tidal Flats off the German Coast (Scharhörn)." (See complete entry in Section V.)

Hamilton, P. "Survey of Marine Wetland and Estuarine Water Quality and Ecological Problems in Corps of Engineers Field Offices." (See complete entry in Section V.)

Hamrick, J. M. "Baroclinic Circulation and Dispersion in Estuaries." (See complete entry in Section III.)

Harper-Owes. 1981. "Duwamish Waterways Navigation Improvement Study: Analysis of Impacts on Water Quality and Salt Wedge Characteristics," US Army Engineer District, Seattle, Washington.

A review of historical water quality data and studies in the Duwamish Estuary has revealed that several changes in water quality conditions have occurred since the mid-1960s. Surface water dissolved oxygen (DO) concentrations have dropped near the head of navigation in response to nitrification of increased ammonia discharged from the Renton Wastewater Treatment plant (RTP). However, salt wedge DO concentrations, which historically have been depressed to 1 mg/l, have increased markedly following sewage diversion from the estuary in the late 1960s. This improvement was found to be principally due to decreased oxygen consumption in the wedge. Based on a comparison of total saltwater wedge consumption (calculated) and sediment oxygen demand (SOD) measurements taken during August 1975, wedge DO uptake was found to be almost solely due [...] (bottom-related). Other factors affecting wedge DO (freshwater input, tidal exchange, and seawater inflow concentration) have not been as significant as [...] consumption. References (44 items).

tidal waters covering the sites. Correlations were observed between coliform counts, Cl⁻ content, and tidal heights. References (15 items).

Kawahara, M., and Hasegawa, K. "Finite Element Analysis of Two-Layered Tidal Flow." (See complete entry in Section VI.)

Knap, A. H., and Williams, P. J. LeB. "Experimental Studies to Determine the Fate of Petroleum Hydrocarbons from Refinery Effluent on an Estuarine System." (See complete entry in Section VI.)

Knox, S., et al. 1984. "Statistical Analysis of Estuarine Profiles: II Application to Arsenic in the Tamar Estuary (S.W. England)," Estuarine, Coastal and Shelf Science, 18(6):623-638.

By combining field observations with a statistical approach and a simple but effective estuarine analogue, the main features of the cycling of arsenic in the Tamar estuary have been elucidated. As(III) and As(V) enrichment in the water column is due to a combination of localized inputs and effective recycling of sediment interstitial waters. The profiles of As(V) are similar to those of NH₄⁺ and are dominated by an estuarine maximum resulting from an input from the sediments. As(III) profiles are correlated with those of dissolved manganese and exhibit both freshwater and estuarine maxima. As(III) appears to be effectively removed at the freshwater brackish water interface by a combination of heterogenous oxidation, catalyzed by hydrous manganese dioxide, and adsorption onto iron oxyhydroxide. The estuarine distribution of As(III) within the water column is consistent with the published rates of oxidation of As(III) to As(V) by both inorganic and microbiological processes. The reduction of As(V) to As(III) in the sediments is incomplete. On the basis of observations, a tentative estuarine arsenic cycle is presented. References (28 items).

Lee, G. F. 1979. "Persistence of Chlorine in Cooling Water from Electric Generating Station," Journal, Environmental Engineering Division, ASCE, 105(EE4):757-773.

A study of the persistence of chlorine in the cooling water discharged to the Delaware River estuary by the Philadelphia Electric Company Eddystone Generating Station showed that potentially toxic levels of chlorine were present 1 hr to 2 hr after discharge for organisms (plankton) entrained in the thermal discharge plume. Based on consideration of chlorine persistence-time of exposure relationships that exist in cooling water thermal plumes, additional monitoring would be expected in fish in the waters used for the cooling water discharge to minimize

Lentsch, J. W., et al. 1971. "Stable Manganese and Manganese-54 Distributions in the Physical and Biological Components of the Hudson River Estuary," Radionuclides in Ecosystems, Proceedings, Third National Symposium on Radioecology, May 10-12, 1971, Oak Ridge, Tennessee, 2:752-768.

The concentrations of stable manganese and ⁵⁴Mn in water, suspended sediments, bottom sediments, plankton, rooted aquatic plants, and fish have been measured in samples from a 30-mile sector of the lower Hudson River Estuary during 1969 and 1970. Manganese-54 has been introduced into this section of the Hudson primarily in operational waste from the Indian Point unit 1 reactor. Manganese-54 data are presented both in terms of activity per unit sample mass and as specific activity. The manganese content of several species of rooted aquatic plants has been found to be proportional to the dissolved manganese concentration in water. However, several species of fish have been shown to regulate manganese uptake or loss and maintain relatively constant manganese levels, regardless of variable concentrations of manganese in water. Manganese dissolved in water appears to be more biologically available than sedimentary deposits of manganese, as indicated by the specific activities of ⁵⁴Mn in water, bottom sediment, and biota. Manganese has been found to leach from bottom sediments when seawater periodically intrudes into freshwater regions of the estuary, thereby increasing the concentrations of manganese in water. The use of concentration factors and specific activities in assessing the dosimetric consequences of ⁵⁴Mn releases into estuaries is discussed, and the limitations of these methods are pointed out. Supplementary data on salinity, freshwater discharge, suspended sediment load, water temperature, pH, and dissolved oxygen are included to allow generalization of observed phenomena to other similar estuaries. References (22 items).

Lippson, A. J., et al. 1981. "Managing Potomac Water Quality: Evolving Approaches," Journal, Environmental Engineering Division, ASCE, 108(3):562-577.

While an ambitious point source control program has yielded measurable improvements in water quality of the Upper Potomac River Estuary, the degree to which additional strict point source controls are needed is the subject of current investigations by Washington area methodologists. The current state of knowledge indicates that implemented controls through the foreseeable future, coupled with a water quality management

despite public expenditures for advanced wastewater treatment. Contributing to poor water quality conditions are significant uncontrolled loadings of oxygen demanding material and nutrients estimated to come from natural sources, unregulated agricultural activities, urban stormwater and other nonpoint pollution sources generated locally and upstream of the Washington region. Area jurisdictions are beginning to reappraise the region's water quality control program with the intent of developing a more comprehensive program that considers pollutant loadings from all sources. Investigations will involve an assessment of the costs of achieving desired water quality levels, and a study of possible mixes of point source, nonpoint source, and combined sewer overflow controls. Studies will involve use of refined predictive models of the estuary which employ new information on the magnitude and fluctuation of pollution loadings. References (5 items).

Macdonald, G. J., and Weisman, R. N. 1977. "Oxygen-Sag in a Tidal River," Journal, Environmental Engineering Division, ASCE, 103(EE3):473-488.

Freshwater flow in a tidal river is incorporated in a dimensionless solution of derived equations for BOD and DO deficit, and profiles obtained with both a constant and a time variable dispersion coefficient are compared. Flow data from the Potomac River, Washington, D.C., are used in computer programs. Increases in river discharge decrease and translate downstream the points of maximum BOD and DO deficit. Time variation of the dispersion coefficient smooths BOD and DO deficit profiles and reduces their peak values. Decisions on the maximum DO deficit associated with a specific effluent outfall appear to be conservative when based on a solution with a constant dispersion coefficient. References (24 items).

Martin, J.-M., and Salvadori, F. 1983. "Fluoride Pollution in French Rivers and Estuaries," Estuarine, Coastal and Shelf Science, 17(3):231-242.

Fluoride concentrations have been determined in major French rivers and estuaries. The unpolluted estuary in the Loire has been compared with the Seine, Gironde, and Charente where important discharges occur. Natural dissolved concentration can be multiplied by a factor of 30. Particulate fluorine concentrations reach almost 2,000 ppm in the Seine estuary. The percentage between free and complexed dissolved fluoride is not affected by the anthropic discharge. The present French rivers' discharge of fluoride is 700 percent higher than the pristine value. At a global scale, dissolved fluoride has probably increased by 25 percent

compared with the natural situation. References (23 items).

†Mogolesko, F. J. 1978. "Development of an Analytical Technique for the Design of a Submerged Thermal Discharging System in a Tidal Estuary," Ph. D. Dissertation, New York University, School of Engineering and Science, New York.

The discharge of waste heat from electric power plants into coastal waters has the potential for adversely affecting the aquatic ecology of receiving waters. In this study, a semi-infinite, shallow receiving body of water is identified as the sink for waste heat from a nuclear power plant. From a review of the open literature, a multiport diffuser is identified as the preferred discharge system for the dispersal of heated discharge effluent. The analysis of the near field surface temperature rise induced by the multiport diffuser under variable tidal conditions is the primary objective of this study.

Montgomery, J. K. 1979. "Predicting Level of Dissolved Reactive Phosphate in the Lafayette River, Virginia, from Information on Tide, Wind, Temperature, and Sewage Discharge," Water Resources Research, 15(5):1207-1212.

The Lafayette River in Norfolk, Virginia, is a shallow, turbid, urban estuary, polluted with primary treated sewage. The river was sampled monthly from October 1970 to January 1972. Oxygen, temperature, and salinity values are vertically and laterally homogeneous in the Lafayette River. The mean values of dissolved reactive phosphate (DRP) in the Lafayette River for the winter (1970-1971 and 1972) ranged from 2.2 to 5.8 microgram-atoms per liter (μg-at ℓ) and for the summer of 1971, 7.6 μg-at ℓ. Multiple linear regression models were prepared to relate the daily changes in phosphate to tide stage, wind component, and rate of phosphate discharge (kg hr) from the Lambert's Point sewage treatment plant. The equations for the August 1971 sample show that the effect of the tide stage is 3 times as important in the determination of the levels of DRP as the rate of flow of DRP from the sewage effluent on the ebbing tide and is equally as important as the rate of flow of DRP from the sewage effluent on the flooding tide. The daily variations in DRP are more noticeable in the summer because of the higher concentrations of phosphate in the Lafayette River during this season. The increase of phosphate on the ebb tide and the decrease on the flood tide over a daily cycle were attributed to a flushing of the water and the Lafayette River by the water in the Hampton Roads. The increase may be a water temperature

to the increased biochemical activities of the microorganisms in the sediment water system. References (33 items).

Morris, F. W., IV, Walton, R., and Christensen, B. A. 1979. "Point and Nonpoint Pollutant Flushing in Tidal Canal Networks," Hydraulic Engineering in Water Resources Development and Management, Proceedings, Eighteenth Congress, International Association for Hydraulic Research, Cagliari, Italia, 10-14 September 1979, 5:91-98.

Extensive, branching networks of tidal canals often exhibit deteriorated water quality due to inadequate flushing, particularly at locations remote from the tidal entrance. Flushing, or the removal of pollutants by convection and dispersion, is effected principally by tidal fluctuations, secondary currents, and wind. Since the hydrodynamics in branching tidal networks is complex, it is necessary to use multidimensional models for the analysis and prediction of canal network flushing effectiveness. A three-dimensional numerical model, based on the convective-diffusion equation solved by the method of second moments with a flexible cell structure, has been developed to assist in the analysis of flushing in tidal canal networks. This model predicts the concentration of a substance, as a function of location and time, for constant or time-varying pollutant inflows at any location in the network and for constant or time-varying winds. Results of simulations on various networks, using this model, show the most effective combination of values for canal network design variables for each particular network. References (6 items).

Nece, R. E., et al. "Effects of Planform Geometry on Tidal Flushing and Mixing in Marinas." (See complete entry in Section VI.)

Novak, P., and Čábelka, J. Models in Hydraulic Engineering; Physical Principles and Design Applications. (See complete entry in Section VI.)

O'Connor, D. J., Mueller, J. A., and Farley, K. J. 1983. "Distribution of Kepone in the James River Estuary," Journal, Environmental Engineering, ASCE, 109(2): 396-413.

An analysis is presented defining the distribution of an organic chemical in the water and bed of an estuarine system. The present structure of the model is a tidally averaged two-dimensional (longitudinal-vertical) main channel interacting with lateral embayments. The water column, segmented into two layers to incorporate the typical estuarine circulation, interacts with a bed which is also segmented into two layers, an active transport layer and a deeper stationary bed. Adsorption-desorption kinetics are included which, in the case of Kepone distribution of the James River, are assumed to be at equilibrium. Both steady-state as well as time-variable conditions are analyzed to calibrate the model to reproduce presently observed concentrations of Kepone. A procedure of analysis to address the problem of organic chemicals in estuaries has been structured. The procedure involves a series of analytic and computational steps, relating to the fluid transport, the solids distribution, and the concentrations of the organic chemical in the water and the bed. The model has been applied to analyze the temporal and spatial distribution of Kepone in the James River under both constant and time-variable freshwater flow conditions. Using actual hydrology and an assumed mass rate of input of Kepone, the concentration was calculated for a 10-year period of production, comparing well to observed values in the water and bed. Projections are presented to estimate the mass contained in the bed and that discharged to Chesapeake Bay. References (15 items).

Officer, C. B. 1981. "Tidal Exchanges and Far Field Effects," Journal Water Pollution Control Federation, 53(10):1551-1552.

The concern, here, is with the far field effects, that is, the wastes returned to the discharge area. Specifically, the discussion is limited to semienclosed bays connected to the ultimate coastal or ocean receiving waters for which the exchanges between the bay and coastal waters are dominated by tidal exchanges. If the discharge is to an open coastal area with dominant coastal currents, the far field effects are often negligible. If the discharge is at some distance up an estuary, the discussion given here does not apply and more sophisticated hydrodynamic considerations must be included. References (4 items).

Olsen, C. R., et al. 1980. "Reactor-Released Radionuclides and Fine-Grained Sediment Transport and Accumulation Patterns in Barnegat Bay, New Jersey, and Adjacent Shelf Waters," Estuarine and Coastal Marine Science, 10:119-142.

A significant portion of radionuclides introduced into the Barnegat Bay environment via global fallout from nuclear weapons testing and by low-level discharges from the Oyster Creek Nuclear Generating Station have been absorbed to fine-grained particles. These provide excellent tracers for fine-sediment transport and accumulation patterns in the bay and adjacent shelf environment. Studies of particle-associated radionuclides present...

shore of Barnegat Bay at rates between 1 and 7 cm/year. Apparently 35-50 percent of the total ^{137}Cs activity in the top 30 cm of the sediments in Oyster Creek is attributable to reactor releases; if transuranic releases have occurred from the Oyster Creek Reactor, the increments of ^{239,240}Pu and ^{238}Pu are not distinguishable from the fallout Pu burden in the sediments; and radiocobalt is removed from the liquid effluent and stored in the sediments at least 20 times more effectively than radiocesium. A budget of ^{60}Co indicates that 40 percent of the ^{60}Co released by the Oyster Creek Reactor resides in the sediments of Barnegat Bay. The accumulation and dispersal patterns of reactive activation products released during routine nuclear reactor operations help determine probable transport pathways of a wide variety of pollutants. References (27 items).

Onishi, S., and Nishimura, T. "Study on Vortex Current in Strait with Remote-Sensing." (See complete entry in Section VIII.)

Orlob, G. T. "Simulation of Estuarial Ecosystems." (See complete entry in Section VI.)

Orlob, G. T. "Water Quality Modeling of Estuaries." (See complete entry in Section VI.)

Owens, M. 1984. "Severn Estuary--An Appraisal of Water Quality," Marine Pollution Bulletin, 15(2):41-47.

The Severn-Trent, Wessex, South West, and Welsh Water Authorities established the Severn Estuary Joint Committee to manage the estuary. The Joint Committee was serviced by a Technical Working Party. The tasks of the Technical Working Party were to: (a) evaluate all existing chemical, biological, and physical data available for the estuary; (b) evaluate all the water quality modeling exercises which have been undertaken on the estuary and assess their usefulness for management of the estuary; (c) identify inadequacies in those data and models; [illegible]

discharged daily into the study area. The Severn Estuary Joint Committee (SEJC) has adopted as a policy that there should be no deterioration in overall water quality in the estuary. Since the evidence available indicates that the existing concentrations of contaminants of interest have not had any adverse effect, the standards adopted are based generally upon existing concentrations. To maintain the standards adopted, the constituent Water Authorities of the SEJC have agreed to consult each other before issuing consents to discharge to the estuary. The standards adopted are consistent with those recommended by the EC and Water Research Centre for implementation of the Directive on Dangerous Substances. References (15 items).

Partheniades, E. 1973. "Ecologic and Thermal Problems in Estuaries," NATO Advanced Study Institute on Estuary Dynamics, Lecture No. 13, Laboratório Nacional de Engenharia Civil, Lisbon, Portugal.

This paper presents the basic characteristics of estuarine systems, pollution and its effect on estuarine ecology, thermal pollution, and artificial ecological changes. It is evident that the proper development and protection of estuarine resources depend on the degree of knowledge of both the hydrodynamics and physical characteristics of the system as well as of the response of the individual species and of the entire estuarine ecosystem to man-made changes in the estuarine regime and in the water quality. Needs for future research and estuarine management are also presented. References (32 items).

Rashid, M. A., and [illegible] Matter in Surficial Sediments [illegible] Miramichi Estuary, New Brunswick [illegible] (See complete entry [illegible]

[illegible]

areas, tidal marshes) for fine sediments.
These designations can be used for more
cost-effective sampling, that is, "focused
sampling" of sediments likely to contain
pollutants. A sediment budget for the
estuary indicates it is a sediment sink,
with the largest input coming from land-
ward sources. This analysis can serve as
a guide to assessment and management of
contaminated environments. References
(25 items).

Rives, S. R., and Pritchard, D. W. "Adapta-
tion of J. R. Hunter's One-Dimensional
Model to the Chesapeake and Delaware Canal
System." (See complete entry in Sec-
tion VI.)

Robinson, I. S. "A Tidal Flushing Model of
the Fleet-An English Tidal Lagoon." (See
complete entry in Section .)

Schwartz, M., and Faughn, W. "Influence
of Temperature Increases on Tidal Rivers
Caused by Waste Heat Discharges with
Respect to Tidal Cycles and Tidal Surges."
(See complete entry in Section .)

lowest in the polluted inner reaches near
large coastal reclamations. The latter
values, about 3.0 ug at. P g⁻¹ lower than
in central Tolo Harbor, might reflect a
selective adsorption of phosphate by rec-
lamation sediments. Organic carbon con-
centrations were high in the inner reaches
and decreased towards the outer channel.
Correlations between phosphorus and or-
ganic carbon were compared with a pub-
lished correlation on the east coast of
England. Hong Kong phosphorus con-
centrations showed a small increase as
organic carbon increased, and less than
one-third of the English values on organic
carbon approximately percent. References
items.

in the sediments were mixed to a depth of
3-4 cm. Although only 12 percent of the
total saturated hydrocarbons added to the
system were found in the sediments, these
hydrocarbons appear to be relatively sta-
ble and were still detectable in these

sediments for ≤6 months after the last oil
addition. References (27 items).

Wood, T. "Discrete-Time Modelling of Dis-
persion in Estuaries." (See complete
entry in Section VI.)

SECTION V. REGULATION AND IMPROVEMENT

Examples and histories of prototype improvements, types and locations of improvements, materials and designs of structures, construction practices, dredging, and the practical aspects of regulation and improvement for navigation, sedimentation, and contamination, and other purposes, as contrasted to the theoretical aspects.

Basu, A. N. "Composite Mathematical Model of Saptamukhi River System Including Outfall Channels for Studying the Effect of Closure." (See complete entry in Section VI.)

Bohlen, W. F. "Factors Governing the Distribution of Dredge-Resuspended Sediments." (See complete entry in Section VIII.)

Bohlen, W. F., and Marine Sciences Department, University of Connecticut. "A Comparison Between Dredge Induced Sediment Resuspension and That Produced by Natural Storm Events." (See complete entry in Section II.)

Brazier, A., and Strachan, W. V. 1978. "Swansea Channel--A Study of Waterways Management," Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:113-122.

This paper discusses the findings of a recently released waterway planning study carried out by the N.S.W. Department of Public Works dealing with the tidal inlet to Lake Macquarie-Swansea Channel. References (20 items).

Breusers, H. N. C., and van Os, A. G. "Physical Modelling of the Rotterdamse Waterweg Estuary." (See complete entry in Section VI.)

Butler, H. L. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 3, Numerical Model Investigation of Plan Impact on the Tidal Prism of Lake Pontchartrain." (See complete entry in Section VI.)

Carr, G. R. "Thames Flood Barrier." (See complete entry in Section I.)

Chatham, C. E. "Los Angeles Harbor and Long Beach Harbor: Design of the Hydraulic Model." (See complete entry in Section VI.)

Coastal Sediments '77, Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE. (See complete entry in Section II.)

Colman, R. S. 1978. "The Modification of a Natural Drainage System and the Subsequent Effects on a Small Estuary and its Surrounding Beaches," Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:160-164.

The important role that catchment management can have on the environmental quality of small, sandy-coast estuaries, and the stability of the surrounding beaches, is illustrated by reference to a case study: Mordialloc Creek estuary The interrelationship between catchment drainage characteristics and freshwater flow variability, and the resultant effect on the estuary and beaches are discussed A typical history of land-coast systems after settlement is summarized. These changes have often necessitated significant morphological change to the estuary to accommodate catchment development, and have greatly altered the freshwater flow characteristics. The subsequent effects are described by analysis of the physical environment, estuary stratification, mixing processes, flushing rates under various flow conditions, and beach sediment movement. In the case study the major problems identified were lack of oxygen supply to the saline wedge of the estuary and the erosion of surrounding beaches. Various options for increasing the supply of oxygen are considered and the effects of current dredging procedures assessed. References (10 items).

Connell, D. W., et al. 1981. "Effects of a Barrage on Flushing and Water Quality in the Fitzroy River Estuary, Queensland," Australian Journal of Marine and Freshwater Research, 32(1):57-63.

Tidal exchange was found to flush the Fitzroy River estuary at a comparatively slow rate, leading to residence times of substances in the estuary of approximately 8 months both before and after barrage construction. The principal mechanism of flushing is displacement by freshwater inflow which gives residence times of 0.2-3.5 months. Freshwater inflow has been decreased by barrage construction and residence times consequently increased. Salinity and dissolved oxygen, total phosphorus, filterable reactive phosphorus, oxidized nitrogen and chlorophyll a concentrations were measured at stations located 20 to 110 km upstream from the mouth of the Fitzroy River. This included that section containing the barrage which was constructed 5 km upstream from Rockhampton. Under conditions of high river discharge (22.6 × 10^{8} m[3]) little variation in water quality was found, but under low discharge conditions (0.035 × 10^{8} m[3]) substantial reductions in dissolved oxygen concentration and increases in nutrient and chlorophyll a concentrations were noted in the zone below the barrage. These results are indicative of the impact of barrage construction on water quality, but more detailed chemical and biological investigations would be needed to unequivocally evaluate water quality status. References (5 items).

Davesne, M., and Graff, M. 1978. "Mathe-
matical and Physical Models for Navigation
in Approach Channels and Harbour En-
trances," Papers, 7th International Har-
bour Congress, K.V.I.V. (Royal Society of
Flemish Engineers), Antwerp, Belgium,
22-26 May 1978, 1:2.09/1-2.09/9.

This paper deals with physical and mathe-
matical models in the Laboratoire National
d'Hydraulique for predicting the path of a
ship under wind, waves, and tidal current
actions. It discusses the capabilities
and limitations of these models and pre-
sents results obtained for the design of
the new outer harbour of Dunkirk and the
new harbour of le Verdon near the mouth of
the Gironde estuary. References
(2 items).

DeWall, A. E., et al. "Inlet Processes at
Eel Pond, Falmouth, Massachusetts." (See
complete entry in Section II.)

Druery, B. M. 1980. "Estuarine Response to
Dredging in the Tweed River, Australia,"
Proceedings, Seventeenth Coastal Engineer-
ing Conference, March 23-28, 1980, Sydney,
Australia, ASCE, II:1599-1618.

Between mid-1974 and mid-1975, 760,000 m³
of sand was dredged from the bed of the
ʺweed River for the purpose of nourishing
cyclone-damaged beaches of the Gold Coast
(Queensland). A comprehensive field data
program was established in 1976 to record
the changes in the hydraulic processes of
the Tweed River brought about by the
dredging. The field measurements demon-
strated that the dredged area was being
infilled with sediments of both marine and
estuarine origin. The dredging increased
tidal ranges throughout the lower estuary,
the effect being more pronounced at low
water. Sediment bed-load rates were esti-
mated from detailed measurements of bed
forms and used to calibrate a sediment
transport formula. The formula was used
in conjunction with a one-dimensional
numerical model of tidal hydraulics to
simulate estuarine shoal dynamics by means
of a simple sediment routing technique.
The results showed that the dredging had
altered the tidal hydrodynamics so as to
enhance the ebb transport of sediment to-
wards the dredged hole. In the long term
it was found that the sediment transport
switched to a weak net upstream movement
of sediment. The detailed hydraulic mech-
anisms involved are discussed. The study
demonstrates that the impact of dredging
can be minimized by location upstream of
the entrance plug of marine sand. Refer-
ences (16 items).

Druery, B. M., and Nielsen, A. F. "Mecha-
nisms Operating at a Jettied River En-
trance." (See complete entry in Sec-
tion II.)

Escoffier, F. F. "Hydraulics and Stability
of Tidal Inlets." (See complete entry in
Section I.)

Everts, C. H. 1980. "Design of Enclosed
Harbors to Reduce Sedimentation," Proceed-
ings, Seventeenth Coastal Engineering Con-
ference, March 23-28, 1980, Sydney,
Australia, ASCE, II:1512-1527.

Sedimentation may be an important problem
when quantities of suspended material are
carried into an enclosed harbor on a
flooding tide. In order to forecast fu-
ture maintenance costs, two methods for
predicting the sedimentation rate prior to
harbor construction are proposed: (a) a
sedimentation tank to be placed at the
proposed harbor site, and (b) a mathemati-
cal model which uses sediment and hydrau-
lic data collected at the harbor site.
Certain considerations in the design phase
of a project may effect a reduction in
harbor sedimentation. If feasible, the
harbor may be sited in a region where
suspended sediment concentrations are low
and sediment sizes (settling velocities)
are small. Proximity to river sediment
sources may be a factor. Conversely, a
harbor site in a clear-water river adja-
cent to a sediment-laden estuary may be
desirable if bed load transport during
freshets would not be a problem. Settle-
ment of suspended material may occur in
the channel which connects an enclosed
harbor basin with navigable waters. This
material may subsequently be resuspended
and carried into the basin, thereby in-
creasing the sedimentation rate. To
reduce that rate, the channel should be
designed as short as possible. A sill in
the channel may also be used to reduce
initial excavation costs and the sedimen-
tation rate. Flotation for vessels in the
basin will be provided at all times, but
movement into and out of the harbor will
be reduced to times of higher water. In
high-latitude areas where harbor use is
limited to periods when ice cover is
absent, the sedimentation rate may be
reduced using a channel closure structure
during nonuse periods. Winter sedimenta-
tion rates can be predicted using the
mathematical model for summer conditions,
and when ice thickness is known. Refer-
ences (5 items).

Falconer, R. A. "Mathematical Model Study
of Mass Transport in Harbours." (See com-
plete entry in Section VI.)

FitzGerald, D. M., Fico, C., and Hayes,
M. O. "Effects of the Charleston Harbor,
S.C., Jetty Construction on Local Accre-
tion and Erosion." (See complete entry in
Section II.)

Fleming, J. H., McMillan, P. H., and
Williams, B. P. 1980. "The River Hull

Tidal Surge Barrier," Proceedings, The In-
stitution of Civil Engineers; Part 1: De-
sign and Construction, 68:417-454.

The River Hull Tidal Surge Barrier is lo-
cated at the confluence of the rivers Hull
and Humber to exclude surge tides from the
River Hull. The concept of the unusual
turnover lift gate and its control system
is set out, together with details of the
design of the gate, the superstructure and
the foundations. Construction included
one of the deepest single-stage cofferdams
ever attempted in the UK, and an account
is given of the design and practical prob-
lems encountered. The project included
some unusual architectural features, an-
cillary flood defenses and a telemetry
system. References (7 items).

Foster, D. N., McGrath, B. L., and Bremner,
W. "Rosslyn Bay Breakwater, Queensland,
Australia." (See complete entry in
Section VI.)

Funke, E. R., and Crookshank, N. L. "A Hy-
brid Model of the St. Lawrence River Estu-
ary." (See complete entry in Section VI.)

Gerrard, R. T., Long, J. J., and Shah,
H. R. 1982. "Barking Creek Tidal Bar-
rier," Proceedings, The Institution of
Civil Engineers; Part 1: Design and Con-
struction, 72:533-562.

Barking Creek tidal barrier is a vital
link in the chain of surge-tide defenses
which extend on the north bank of the
River Thames from the Thames Barrier at
Woolwich down to Leigh on Sea. The design
and construction of the barrier are de-
scribed. Of particular interest are the
cofferdams and the arrangements for in-
stalling the 300-t navigation span gate
which is believed to be the largest
vertical-lift gate in the UK. Reference
(1 item).

Gibson, R. A., and Wilson, E. M. 1979.
"Tidal Energy Integration Using Pumped
Storage," Journal, Energy Division, ASCE,
105(EY1):71-80.

This paper shows how the value of tidal
energy is enhanced when it is integrated
into an electrical system using a pumped-
storage scheme. An optimum operations
policy for the combined tidal and pumped-
storage schemes has been determined by a
dynamic programming method. This objec-
tive has been demonstrated for a tidal
energy scheme in the Minas Basin, Bay of
Fundy, and a pumped-storage scheme on the
St. John River, Maine. References
(3 items).

Giese, E. H. T. 1978. "Use of an Estuary
Mobile Bed Model to Investigate Natural
Sedimentation Processes," Proceedings,
International Conference on Water

Resources Engineering, Asian Institute of
Technology, Bangkok, Thailand, January 10-
13, 1978, I:243-253.

The hydraulic institute BAW is operating a
tidal model with a movable bed for the
improvement of the Elbe-estuary navigation
channel (North Sea). Earlier tests, for
the interrelationships of unsteady alter-
nating flows and morphological changes,
showed a good agreement between model and
prototype, so that it is now conventional
to investigate future training work. New
investigations have been carried out for
the deepening of the fairway, now under
construction, to find out future annual
dredging rates, sections with accretion
concentrations, and the main sediment
transport directions. In the latter case
the locally limited transport processes
have been investigated with the help of
radioactive tracers, both for model and
prototype. References (7 items).

Göhren, H., and Christiansen, H. 1978.
"Ecological Aspects of a Deep Water Port
in the Tidal Flats off the German Coast
(Scharhörn)," Papers, 7th International
Harbour Congress, K.V.I.V. (Royal Society
of Flemish Engineers), Antwerp, Belgium,
22-26 May 1978, I:6.04/1-6.04/19.

After extensive field investigations
(since 1964), Hamburg had, for the first
time, in 1970 submitted the plans for the
construction of a deep water port in the
tidal flats around Neuwerk/Scharhörn.
This area lies south of the more than
20-m-deep outer Elbe fairway off the North
Sea coast. In these plans it is intended
to dredge out a maneuver basin and a 1.5-
km-long harbor basin connected to the deep
natural fairway. With the dredged mate-
rial from the excavation a 12-km^2 island
will be reclaimed. The bottom height of
the whole area will be above the highest
storm surge level. A sand dam of some
18 km in length connects the port with the
network of railways, roads, and supply
ducts on the mainland. In 1974 the Scien-
tific Committee for General Ecological
Problems, a team of 11 scientists, each
with a different scientific field, were
authorized to examine the proposed plans.
These experts were given the task of test-
ing the environmental compatibility of the
port project comprehensively and of sug-
gesting plans or measures to prevent harm-
ful consequences as well as of proposing
how to obtain favorable results. In 1976
the Committee submitted their report.
This report contains statements of possi-
ble consequences as well as recommenda-
tions for plan changes and results of the
project. References (17 items).

Gordon, D. C., and Longhurst, A. R. 1979.
"The Environmental Aspects of a Tidal
Power Project in the Upper Reaches of the

Bay of Fundy," Marine Pollution Bulletin, 10(2):38-45.

Environmental planning is discussed, and the possible effects of the Bay of Fundy tidal power scheme are considered in terms of physical oceanography, hydrology, climatology, and sedimentology. Environmental studies for the Severn Barrage are related to possible effects in the Bay of Fundy. A firm recommendation for preinvestment design studies has been made, backed by provincial and federal governments, and specific impact assessment studies will be commissioned by the proponent if the project is authorized to proceed. References (11 items).

Granat, M. A., and Gulbrandsen, L. F. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)

Hales, L. Z. 1985. "Erosion Control of Scour During Construction; Report 8, Summary Report," Technical Report HL-80-3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

When major stone structures such as jetties, breakwaters, or groins are erected in the coastal zone, they alter the existing tidal, wave-induced, or wind-driven currents that are in a dynamic equilibrium with the existing bathymetry. These altered currents and waves breaking on such structures under construction may change the existing bathymetry by causing bottom material to be suspended and transported from the region. This removal of material from around structures is often not compensated for by an influx of additional material, and the result is a scour hole that usually develops in the near vicinity of the toe of the partially completed structure. In order to ensure structural stability, any such scour area must be filled with nonerodible material (sufficiently stable to withstand the environmental forces to which it will be subjected) to allow construction to proceed to completion. This may result in significant additional quantities of material being required during construction that can potentially lead to substantial cost overruns. Four fundamentally different materials are presently being used to combat scour from wave-induced erosion around major stone structures: (a) a layer of crushed or quarry-run stone (graded or ungraded) placed as a foundation blanket on sandy or otherwise semiconsolidated foundations to prevent upward migration of loose materials and settlement of larger stone sizes, (b) fabricated gabion units placed underneath stone structures to form a continuous layer in lieu of a crushed stone foundation blanket, (c) a wide assortment of synthetic filter fabrics

placed underneath rock structures to prevent settlement into otherwise unconsolidated foundations, and (d) to a lesser extent, the use of Gobimats, particularly for toe protection of shore-connected structures such as seawalls or slope revetments. The objectives of this research were to develop techniques and knowledge for estimating resulting wave characteristics and wave-induced current fields in the vicinity of major coastal structures. Both analytical and laboratory experimental studies were conducted during the investigation. The analytical developments regarding wave heights and wave-induced currents were verified by the use of precise experimental studies of shore-connected breakwaters. Additional under-layer stability experimental studies were conducted for estimating the size of stone comprising the foundation bedding material which would remain stable under various wave conditions. A two-dimensional finite element numerical simulation model (FINITE) was developed by Houston and Chou that calculates wave heights under combined refraction and diffraction for both long and short waves approaching structures from any arbitrary direction. The wave equation solved governs the propagation of periodic, small-amplitude, surface gravity waves over a variable-depth seabed. A computation scheme is employed that allows the solution of large problems with relatively small time and memory storage requirements, necessary for practical problem solutions. A generalized wave-induced current numerical model (CURRENT) was developed by Vemulakonda to estimate the magnitude of longshore currents and nearshore circulations in the vicinity of structures. This model retains the unsteady terms of the equations of motion, as well as advection and lateral mixing terms. Comparisons with known analytic solutions and experimental results provided good agreement. The model was successfully applied to a complex actual prototype field situation with reasonable results.

Hamilton, P. 1980. "Survey of Marine Wetland and Estuarine Water Quality and Ecological Problems in Corps of Engineers Field Offices," Miscellaneous Paper EL-80-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents the results of a survey of Corps of Engineers (CE) field offices that have coastal zone responsibilities. The purpose of the survey was to investigate existing or anticipated water quality and ecological problems associated with CE activities in marshes and estuaries. Emphasis was placed on identifying those problems amenable to analysis through application of predictive modeling techniques. Three general

problems were emphasized by all officers:
(a) the uniqueness of the specific environments in their District; (b) water quality and environmental problems as functions of local concerns of the public; and (c) the need to evaluate effects of a change in physical regime on an estuary. These specific problems are identified: (a) Techniques are needed to predict the effects of CE activities on the hydrodynamics, dissolved and particulate transport, biological and chemical processes, and biota in coastal environments. CE activities include construction, channel deepening and widening, island creation, and upstream projects leading to changes in freshwater flows. (b) Selected marsh/estuarine areas need to be characterized in terms of physical, chemical, and biological structure and chemical and biological processes. Specific areas identified include the east and northeast coasts, infrequently flooded marshes, mangrove swamps, and buffer areas such as the saline flatlands of the western gulf. Included in the characterization would be a uniform methodology of classification and a means to assess the value of the wetland to the total ecosystem. (c) The types and magnitudes of stresses the marsh/estuarine ecosystem may be subjected to in terms of structural stability and deviations in the rates of selected chemical and biological processes need to be determined. Included would be estimation of the assimilative capacity for effluents from diked impoundments, dredged material disposal sites, storm runoff, and agricultural runoff. Indices of structure and processes include fish and invertebrate nursery grounds, fish production, water quality, and import/export relationships of nutrients and detritus. (d) Techniques to evaluate the cumulative impacts of dead-end canals, small boat harbors, and marinas on the adjacent coastal ecosystem need to be developed. Procedures are needed to assess the magnitude of perturbations of water quality due to point and nonpoint sources of contaminants entering the canals and small harbors. Design criteria to minimize adverse water quality degradation within the canals and harbors and in the adjacent ecosystem need to be formulated. (e) An increased understanding is needed of the process of marsh creation through deltaic growth including habitat creation and species succession. (f) Existing hydrodynamic models need to be extended by including selected water quality parameters in advection-dispersion equations. Priority of inclusion is salinity, temperature, dissolved oxygen, nutrients, phytoplankton, and toxicants.

Harper-Owes. "Duwamish Waterways Navigation Improvement Study: Analysis of Impacts on water quality and salt wedge circulation." (See complete entry, Section VI.)

Harten, H. 1978. "Improvement of Tidal Estuaries and the Effects of Tidal Current." Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany. ASCE. III:2905-2914.

With the enlargement of industrialization in the 19th century and the growth of world trade, the sea navigation increased considerably. The sea routes had to be improved. This development continued very fast in the last 30 years. The capability of extension in the particular estuary (for example, Elbe, Weser, Jade, Ems) is limited. The improvements include not only the deepening of navigational channels, but also groins, training walls, fixation of bars, partial or total damming up from bychannels, new localization of main navigational channel lines, new ports, etc. The tidal low water falls and the tidal high water rises, the tidal lift and the tidal volume increase, and the flood, as well as the ebb current, floats more powerfully through the tidal estuary. This shows the effect of constructions. References (5 items).

Havnoe, K., Kej, A., and Siefert, W. "Mathematical Modelling of Water Levels and Flows in the Port of Hamburg." (See complete entry in Section VI.)

Hayes, M. O., Kana, T. W., and Barwis, J. H. "Soft Designs for Coastal Protection at Seabrook Island, S.C." (See complete entry in Section VIII.)

Hayter, E. J., and Mehta, A. J. "Verification of Changes in Flow Regime Due to Dike Breakthrough Closure." (See complete entry in Section VI.)

Higgs, K., Treloar, P. D., and Lawson, N. V. 1978. "Comparison of Results from Physical and Mathematical Tidal Flow Models with Prototype Data in Botany Bay," Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:190-195.

An overall environmental investigation into the effects of port development in Botany Bay is being carried out under the control of the State Pollution Control Commission of New South Wales. Information on water movement is needed as a basis for understanding problems such as water pollution and sedimentation, and for planning and managing the bay. As part of this work a distorted scale physical model has been built by The University of N.S.W. and a development of the Fischer

mathematical model is being operated by
the Maritime Services Board (N.S.W.)
Prototype current data have also been
obtained using three Aanderaa recording
current meters. These three projects
have been closely coordinated so that
their results could be compared. This
paper describes this work, compares the
manner in which the models are operated,
and discusses their limitations. Model
results are also compared with prototype
data. References (4 items).

Harrjohns, H. 1978. "Coastal and Catastro-
phe Protection in the Area of the German
Bay," Wasserwirtsch, 68(2):46-50 (in
German)

A discussion of the completed and planned
hydraulic engineering measures in special
consideration of the storm tide of Janu-
ary 3, 1976, and the various contradictory
opinions mentioned in connection with this
event. References (15 items).

Hodgson, R. T., Pettibone, B., and Sullivan,
S. M. "Siltation Study of Humboldt Bay
Marina, California." (See complete entry
in Section II.)

Hommel, H., and Koehler, G. "Reservoir-
Model for Low-Water Regulation in Tidal
Influenced Areas." (See complete entry in
Section VI.)

Horie, T., Sato, S., and Murakami, K.
"Boundary Treatment on Tidal Current Com-
putation." (See complete entry in Sec-
tion VI.)

Horner, R. W. 1981. "The Thames Barrier,"
Journal of the Institution of Water Engi-
neers and Scientists, 35(5):398-411.

In 1972 the decision was taken jointly
by the Government and the Greater London
Council (GLC) to protect the low-lying
areas of central London from flooding re-
sulting from surge tides in the southern
North Sea, by building a flood defence
barrier in the western half of Woolwich
Reach. This paper gives the background
to the design of the structure and details
the progress of the construction up to
date. Operation techniques are described
and possible benefits from operation of
the Barrier in other roles than that of a
flood defence structure are discussed.
References (2 items).

Hsueh, S. F., and Ahlert, R. C. "Mixing in
Shallow Coastal Sea: Case Study." (See
complete entry in Section VI.)

Hutchison, I. P. G., and Midgley, D. C.
"Mathematical Modelling of Water Level and
Salinity Regimes in Some South African
Lake and Estuary Systems." (See complete
entry in Section VI.)

Kawahara, ... "Finite ...
Two-layer tidal flow ..." (See complete
entry in Section ...)

Kendrick, M. P., and ...
1978. "Effects of a Barrier on Existing
Estuary Regime," Proceedings, Conference
on Thames Barrier Design, London, 5 & 6
October 5, 1977, The Institution of Civil
Engineers, Paper 54-58

A summary of the studies undertaken to
determine the effect on the existing estu-
ary regime of the construction and opera-
tion of a Thames Barrier. References
(58 items).

Kerssens, P. J. M., Prins, A., and Van Rijn,
L. C. "Model for Suspended Sediment
Transport." (See complete entry in Sec-
tion VI.)

Kerssens, P. J. M., Van Rijn, L. C., and Van
Wijngaarden, N. J. "Model for Non-Steady
Suspended Sediment Transport." (See com-
plete entry in Section VI.)

Kieslich, J. M. "A Case History of Port
Mansfield Channel, Texas." (See complete
entry in Section II.)

Kieslich, J. M. 1981. "Tidal Inlet
Response to Jetty Construction," GITI
Report 19, US Army Engineer Waterways
Experiment Station, Vicksburg, Miss.

Thirteen tidal inlets located on the
Atlantic, Gulf, and Pacific coasts of the
continental United States were selected
for a study of the response of inlet ocean
entrances to man-made improvements. Inlet
entrance behavior following jetty con-
struction were evaluated and guidelines
for the functional design of inlet en-
trance improvements are suggested. The
inlets considered in the study were those
where a single updrift or downdrift jetty
was built first. Literature cited
(48 items); bibliography (16 items).

Komar, P. D. Beach Processes and Sedimenta-
tion. (See complete entry in Section I.)

Krause, G. "Separation of Climatic Fluctua-
tions and Impacts of Engineering Activi-
ties in Estuaries." (See complete entry
in Section III.)

Leenknecht, D. A., Earickson, J. A., and Butler, H. L. "Numerical Simulation of Oregon Inlet Control Structures' Effects on Storm and Tide Elevations in Pamlico Sound." (See complete entry in Section VI.)

Liu, S. K., Hou, H. S., and Chang, C. C. "Simulation of Wave Wind Forced Harbor Oscillation." (See complete entry in Section VI.)

McAnally, W. H., Jr., Brogdon, N. J., Jr., and Stewart, J. P. "Columbia River Estuary Hybrid Model Studies; Report 4, Entrance Channel Tests." (See complete entry in Section VI.)

McAnally, W. H., Jr., et al. "Application of Columbia Hybrid Modeling System." (See complete entry in Section VI.)

McAnally, W. H., Jr., et al. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth." (See complete entry in Section VI.)

McKay, G. R., and Tranberg, C. H. 1978. "The Development of a Dredged Estuarine Harbour--A Case Study," *Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering*, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:196-200.

A case study is presented which describes the investigations and implementation of the works associated with the development of the new shipping channels for the Port of Bundaberg, Queensland. This Port is an estuarine harbour, typical of many on the eastern seacoast of Australia, and has experienced a long history of siltation. In 1976 the Port was upgraded to accommodate larger vessels, and the opportunity was taken to redesign the shipping channel configuration to obtain a more favourable situation with regard to harbour siltation and navigation requirements. References (8 items).

Magoon, O. T., and Baer, D. C. "Maintenance of Santa Cruz Harbor, California, USA." (See complete entry in Section II.)

Mangarella, P. A., and Robilliard, G. A. 1978. "Thermal and Biological Impact of LNG Vaporizer Discharge," *Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany*, ASCE, III:2945-2957.

A simplified steady-state multilayered (horizontally homogeneous) thermal model is described and applied to assess the effects of the cold-water discharge created by a proposed liquid natural gas

(LNG) regasification facility. The model, similar to ones developed for predicting average cooling pond performance, accounts for advection and diffusion between layers, atmospheric and solid boundary heat exchange, and heat exchange due to tidal and density currents. For the configuration in which both the intake and discharge were located in a dredged turning and docking basin, recirculation created thermal deficits from -8° C to -17° C. Adverse environmental effects on migrating species (particularly various life stages of shrimp) and the benthic community and costs associated with auxiliary seawater heating suggested that other alternatives (such as a separate intake basin or an offshore diffuser) would be more appropriate. References (6 items).

Marche, C., et al. "A Study of the Influence of River Discharge Regulation on the Salinity Equilibrium in the Estuary." (See complete entry in Section III.)

Maza, J. A., Munoz, M. L., and Porraz, M. 1977. "Jetties Studies Contribution," *Coastal Sediments '77, Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE*, Charleston, South Carolina, November 2-4, 1977, ASCE, 248-266.

This paper presents a series of studies on a hydraulic model related to the influence on the coastal line and environment that surrounds the convergent jetties that will protect the communicating channel between the ocean and the coastal lagoon or simply a water intake. All the basic research was carried out in the laboratory and based on a classic solution for this type of structure. Several positions were tried. The actual orientation of the jetties was also changed in relation with the coastline; and their effect against two different wave directions was measured, one perpendicular to the shoreline and another with a 30-deg tilt direction. Keeping constant the incoming flow and outflow in the channel, different geometrical configurations were tested with speed measured at several checkpoints for different tide and wave conditions. From the results and analysis of behavior under the mentioned parameters, some design recommendations are included as conclusions.

Nece, R. E. "Planform Effects on Tidal Flushing of Marinas." (See complete entry in Section VI.)

Nece, R. E., and Smith, H. N. "Tidal Exchange in Proposed Sitka, Japonski Lagoon, Small Boat Harbor." (See complete entry in Section VI.)

Nece, R. E., et al. "Effects of Planform Geometry on Tidal Flushing and Mixing in

Marinas." (See complete entry in Section VI.)

Nishimura, J. K., and Lau, L. S.   1979. "Structure for Automatic Opening of Closed Stream Mouths," Shore and Beach, 47(4):3-8.

Closure of stream mouths by littoral sediment is a natural condition of numerous small streams on islands like Oahu, Hawaii. A new design of a hydraulic structure with nonmoving parts for automatic opening of coastal sediment plugs at small stream mouths has been developed. Investigation of literature on the inlet closure phenomenon and of Oahu streams identified three major factors that contribute to stream blockage. Generally, closed streams have small tidal prisms (inlet surface area times tidal differential between MLLW and MHHW), large amounts of wave power exposure, and little or no (intermittent) streamflow. As a result, it was concluded that closed stream mouths were the natural condition of numerous Oahu streams. Present methods being implemented in Hawaii include the construction of jetties, dredging, and the use of hydraulic outlet structures. Jetties are effective deterrents to inlet closure, but they are not always feasible for small stream mouths and certain offshore conditions. On Oahu, dredging is the most common method used for clearing stream mouths. References (9 items).

Nishimura, J. K., and Lau, L. S.   "Structure for Automatic Opening of Sediment Plugs." (See complete entry in Section II.)

Novak, P., and Čábelka, J. Models in Hydraulic Engineering; Physical Principles and Design Applications. (See complete entry in Section VI.)

Odd, N. V. M., and Baxter, T. "Port of Brisbane Siltation Study." (See complete entry in Section VI.)

Outlaw, D. G. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 1, Prototype Data Acquisition and Analysis." (See complete entry in Section I.)

Owen, A. "Effect on the M_2 Tide of Permeable Tidal Barrages in the Bristol Channel." (See complete entry in Section VI.)

Prandle, D. "Modelling of Tidal Barrier Schemes; An Analysis of the Open-Boundary Problem by Reference to AC Circuit Theory." (See complete entry in Section VI.)

Price, W. A., Motyka, J. M., and Jaffrey, L. J.   1978. "The Effect of Offshore Dredging on Coastlines," Proceedings, Sixteenth Coastal Engineering Conference,

August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1347-1358.

This paper deals briefly with the licensing procedure and at some length with the involvement of the Hydraulics Research Station (HRS) in assessing how dredging might affect the coastline. In conclusion, the following questions and answers were presented on the subject: (a) Is the dredging far enough offshore that beach drawdown into the hole cannot take place? The approximate limit for onshore/offshore movement off the south coast of England is considered to be about 10 m below low water and this is usually taken as the minimum depth to ensure that beach drawdown will not take place into the hole. There is also a limit in terms of distance offshore of 600 m. This criteria is hardly ever invoked because it is usually overridden by other considerations. (b) Is dredging to be carried out in deep enough water so that the hole will not intercept the onshore movement of shingle? Field tracer studies have shown that for the south coast wave climate and in regions of weak tidal currents shingle will not move in depths greater than 18 m. A method of including the effect of tidal currents has been developed. It is believed to err on the safe side. As an example, the 18-m criterion changes to 22 m for a tidal current of 1.1 m/sec. However it is stressed that the method is at an early stage of its development. (c) Does the dredging area include banks which if removed would increase wave activity at the shoreline? In this case it is usual for the application to be turned down. There are exceptions under special conditions. If, for example, it can be shown that the beach is well protected from wave attack, e.g., by a very wide foreshore, then dredging of a limited quantity of material under controlled conditions may be allowed. For such special cases a desk study is carried out by HRS. (d) Is the area sufficiently distant from the shore and in deep enough water so that changes in wage refraction over the dredged area do not lead to changes of littoral transport at the shoreline and hence changes in beach plan shape? A beach mathematical model developed at HRS has shown that in general the effects of wave refraction are insignificant when dredging takes place in water depths greater than 14 m. References (14 items).

Ramming, H.-G. "The Influence of River Normalization on the Distribution of Tidal Currents in the River Elbe." (See complete entry in Section I.)

Raney, D. C. "Los Angeles Harbor and Long Beach Harbor: A Numerical Model for Tidal Circulation." (See complete entry in Section VI.)

Renger, E., and Partenscky, H. W. "Sedimen-
tation Processes in Tidal Channels and
Tidal Basins Caused by Artificial Con-
structions." (See complete entry in Sec-
tion I.)

Richards, D. R., and Morton, M. R. "Norfolk
Harbor and Channels Deepening Study; Re-
port 1, Physical Model Results; Chesapeake
Bay Hydraulic Model Investigation." (See
complete entry in Section VI.)

Seabergh, W. C. 1977. "Jetty Design for
Little River Inlet, South Carolina,"
Coastal Sediments '77, Fifth Symposium of
the Waterway, Port, Coastal and Ocean
Division of ASCE, Charleston, South Caro-
lina, November 2-4, 1977, ASCE, 966-985.

A dual weir jetty system for Little River
Inlet, South Carolina, was designed with
the aid of a fixed-bed model. The dis-
torted scale (1:60 vertical and 1:300 hor-
izontal) tidal model was used to develop a
plan which would minimize construction
cost and provide a stable nonsilting en-
trance channel. Verification of tidal
elevations, tidal currents, and salinities
resulted in good model-prototype agree-
ment. The preliminary testing program
consisted of examining a variety of struc-
tural configurations in the model with
surface current photographs from which the
best plans were selected for more detailed
investigation. Included in the testing of
plans for the inlet was the use of a
lightweight plastic sediment as a tracer
in order to gain a better understanding of
the movement of sediment in the vicinity
of the jetty system where both tidal cur-
rents and wind waves are interacting.
Analysis of this type of testing with
time-lapse motion pictures proved ex-
tremely useful in evaluating jetty design.
The paper also includes a review of the
inlet's past behavior and factors influ-
encing inlet changes. The model proved to
be an integral part of the functional de-
sign of the weir jetties, especially with
respect to the evaluation of the weir ele-
vations and locations necessary for con-
ditions conducive to the movement of
sediment over the weirs and into the bay-
side deposition basins. Model testing
also contributed to economic savings by
determining the extent that jetty length
could be reduced without detrimental
effects. References (12 items).

Seabergh, W. C. "Model Testing of Struc-
tures at a Tidal Inlet." (See complete
entry in Section VI.)

Seabergh, W. C. 1983. "Weir Jetty Perfor-
mance: Hydraulic and Sedimentary Consid-
erations; Hydraulic Model Investigation,"
Technical Report HL-83-5, US Army Engineer

Waterways Experiment Station, Vicksburg,
Miss.

The investigation was performed to study
important design parameters for a weir
jetty system including weir length, ele-
vation, orientation with respect to the
shoreline and the conventional portion of
the jetty structure, tidal currents over
the weir section, flow patterns in the vi-
cinity of the weir section, sediment move-
ment over the weir and effects of the weir
jetty on accretion, and erosion upcoast of
the jetty system. Results indicate the
mean tide level weir elevation is the most
practical elevation for providing wave
protection for a dredge, good sediment
transport across the weir, and good flood-
ebb tidal flow relationships, i.e., mod-
erate flood flow currents and little or no
ebb flow. Strong ebb flow currents over
the weir are not desirable as they might
aid in migration of the navigation channel
through the deposition basin. Jetty
systems with the outer, more oceanward
portions parallel to each other and at
minimum spacing provide the best flow
characteristics when tidal current migra-
tion through the deposition basin region
is considered. Wave-generated currents
upcoast of the weir jetty are not entirely
captured by the weir but some current, and
thus sediment, move oceanward along the
outer portion of the jetty. Also re-
flected waves off the jetty and weir
structure combine with incident waves to
form a short-crested wave field which aids
in removal of sediment from the upcoast
beach to various degrees, depending on the
structure's angle with respect to the
shoreline and the incident wave angle.

Seabergh, W. C., and Lane, E. F. "Improve-
ments for Little River Inlet, South Caro-
lina; Hydraulic Model Investigation."
(See complete entry in Section VI.)

Seabergh, W. C., and Outlaw, D. G. "Los
Angeles and Long Beach Harbors Model
Study; Numerical Analysis of Tidal Circu-
lation for the 2020 Master Plan." (See
complete entry in Section VI.)

Seabergh, W. C., and Sager, R. A. "Supple-
mentary Tests of Masonboro Inlet Fixed-Bed
Model; Hydraulic Model Investigation."
(See complete entry in Section VI.)

Sorensen, R. M. "The Corps of Engineers
General Investigation of Tidal Inlets."
(See complete entry in Section I.)

Sorensen, R. M., and Schmeltz, E. J. 1982.
"Closure of the Breach at Moriches Inlet,"
Shore and Beach, 50(4):33-40.

Moriches Inlet, on the south shore of Long
Island, New York, is the jettied entrance
to Moriches Bay from the Atlantic Ocean.

During the last three decades, the pattern of tidal flow through the inlet has caused a narrowing of the barrier beach adjacent to the inlet's east jetty. Then, in January 1980 a storm breached the narrow section and subsequent erosion rapidly expanded the width of the breach. As a result of local concerns regarding increased exposure of backbay areas to storm-induced flooding, as well as the effect of salinity changes in the shellfish industry, the Army Corps of Engineers decided to close the breach. This paper briefly summarizes the recent history of Moriches Inlet, development of the breach, and postbreach changes in the vicinity of the inlet; and presents a description of the construction operations that closed the breach. References (6 items).

Sternberg, R. W., et al. 1977. "Aquatic Disposal Field Investigations, Columbia River Disposal Site, Oregon; Appendix A: Investigations of the Hydraulic Regime and Physical Nature of Bottom Sedimentation," Technical Report D-77-30, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

A two-part study was conducted in a region seaward of the Columbia River where disposal of large quantities of dredged material has occurred over the last several decades. The first part included repeated bathymetric surveys and sampling for distribution and seasonal variations of sediment texture and mineralogy throughout the study area, and especially at designated disposal sites. Near-bottom hydraulic conditions (waves, tides, currents, turbidity) were also measured at several sites and during all seasons. The second part was related to an experiment in which 600,000 cu yd of material dredged from the Columbia River estuary was dumped at a specially designated site, which was monitored before, during, and after disposal. The objectives of the sedimentological aspects of the study were to identify and map all deposits of dredged material and to recognize seasonal and long-term changes. The objectives of the hydraulic aspects were to document the ambient near-bottom conditions, and their effect on the deposit at the experimental site. References (9 items).

Stroband, H. J., and Wijngaarden, N. J. V. "Modelling of the Oosterschelde Estuary by a Hydraulic Model and a Mathematical Model." (See complete entry in Section VI.)

Sündermann, J., and Elahi, K. Z. "Constructional Effects on the Dynamical Processes in a Tidal Inlet." (See complete entry in Section VI.)

Sündermann, J., and Holz, K.-P., ed. Mathematical Modelling of Estuarine Physics, Lecture Notes on Coastal and Estuarine Studies. (See complete entry in Section I.)

Svasek, J. N., and Versteegh, J. "Mathematical Model for Quantitative Computations of Morphological Changes Caused by Man-Made Structures Along Coasts and in Tidal Estuaries." (See complete entry in Section VI.)

Tocker, P. 1979. "Stop Father Thames Flooding," Soil & Water, 15(6):23-26.

In London, a massive scheme to protect the Thames valley from flooding from the sea is under construction by the Greater London Council. The main feature is a barrier across the Thames near Greenwich, which can be raised to prevent a flood reaching London. High water levels at London Bridge have been rising by about 0.76 m per century. This progressively increases the risk of flooding in London. A study of the tidal regime of the River Thames suggests a number of natural causes, the settlement of the land relative to the level of the sea in the southeast of England is probably the most significant. It has been suggested that this tilting (roughly around the axis to the England/Scotland border) may be a readjustment in compensation for the melting of ice sheets from the last Ice Age. Another natural cause is the rise in sea level resulting from the melting of ice masses. The most important artificial cause is probably the dredging and embanking of the Thames estuary. This tends to funnel the tidal flow, "canalization," resulting in an increase in the tidal range of the Thames.

Trafford, B. D. 1981. "Background to the Flood Defences of London and the Thames Estuary," Journal of the Institution of Water Engineers and Scientists, 35(5): 383-397.

The rise of tidal levels and the effect of storm surges in the North Sea make the Thames vulnerable to flooding. Work costing towards £700 million is now in hand to provide increased protection. The main feature is the barrier at Woolwich, but works include other barriers on tributaries and about 112 km of floodwalls or banks. Completion is scheduled for 1982 and will provide protection against a flood which has a probability of occurring once, on average, in any 1,000 years. The warning system which will trigger the closure of the defences is discussed together with potential future developments. References (10 items).

Trawle, M. J. 1981. "Effects of Depth on
Dredging Frequency; Report 2, Methods of
Estuarine Shoaling Analysis," Technical
Report H-78-5, Report 2, US Army Engineer
Waterways Experiment Station, Vicksburg,
Miss.

Whenever deepening of a dredged channel is
under investigation, a prediction must be
made as to the effect of the deepening on
the existing dredging requirements. If
the deepening is related to advance main-
tenance dredging rather than to an in-
crease in authorized depth, the prediction
becomes even more difficult because the
project is allowed to shoal over a wide
range of depth. Currently a variety of
arbitrary, rule-of-thumb procedures are
used for predicting the effect of in-
creased depth on dredging requirements.
The overall objective of this investiga-
tion was to evaluate the effectiveness of
advance maintenance dredging in reducing
dredging frequency and/or costs in the
maintenance of coastal channels and har-
bors and to establish necessary guidelines
for governing the practice. This report,
the second of a series, presents an empir-
ical method of shoaling analysis based on
historical dredging and shoaling records
that results in reliable predictions of
future shoaling for deepened channel con-
ditions resulting from either an increase
in authorized channel depth or advance
maintenance. The method presented was
designed to be general enough so that it
can be applied to most navigation projects
without difficulty. The procedure was
described step by step using an example
(fictitious) project. To demonstrate how
the method would be applied to real navi-
gation projects and to point out problems
that occur when evaluating real projects,
selected Galveston Bay, Texas, navigation
projects were evaluated and the results
discussed.

US Army Engineer Division, New England.
1981. "Long Island Sound, Thamesville
Tidal-Flood Management Water Resources
Study, Norwich, Connecticut," Reconnais-
sance Report, Waltham, Mass.

The study provides a planning and manage-
ment tool in the development of alterna-
tive solutions to reduce Thamesville's
tidal-flood damage. This Stage 1 report
only identifies the problems, needs, and
opportunities of the study area and then
the level of detail required to formulate
any intermediate plans.

Vallianos, L. 1980. "Barden Inlet, N.C.:
A Case Study of Inlet Migration," Proceed-
ings, Seventeenth Coastal Engineering Con-
ference, March 23-28, 1980, Sydney, Aus-
tralia, ASCE, III:2640-2654.

The migratory pattern of a small coastal
inlet was examined in terms of the factors

generally acknowledged to control inlet
behavior; that is, the tidal discharge
which acts to flush the inlet and, on the
other hand, the intrusive littoral mater-
ials depositing in the inlet environment.
Specifically, a flow conveyance index was
computed and compared to shoreline move-
ments. The flow conveyance index was
defined as the ratio of the mean distribu-
tion of the overall planform area of the
throat of the inlet to the mean distribu-
tion of the planform areas of shoals
within the throat of the inlet. High and
low flow conveyance index values would
correspond, respectively, to periods of
relatively high and low inlet flushing
conditions. A consistent pattern was
obtained from this analysis, wherein high
and low index values corresponded with
high and low shoreline movements. Addi-
tionally, the plot of rates of shore move-
ments against rates of change of flow con-
veyance index was fitted with a simple
linear regression line having a positive
correlation coefficient of 0.85. Further
analyses of the mean distribution of the
shoals within the throat of the inlet dem-
onstrated the cause of time-varying rates
of movement of points along the spirifer-
ous east shoreline of the inlet. Shore-
line movement rates were plotted on a
time-space plane and isolines of shore
movement rates contoured. The result was
a three-dimensional image of shore move-
ment rates over time and distance. The
position of the centroid of the inlet
shoal distribution at different times was
superimposed upon the three-dimensional
image. This revealed that variations of
shoreline movement rates along the shore
at any point in time are dependent on the
mean position of the inlet shoal distribu-
tion. Also, the direction of movement of
the mean position of the inlet shoal dis-
tribution appeared to indicate the predom-
inant direction of flushing action, that
is, flood or ebb tides.

van de Kreeke, J., and Haring, J. "Stabil-
ity of Estuary Mouths in the Rhine-Meuse
Delta." (See complete entry in Sec-
tion II.)

van de Ree, W. J., Voogt, J., and Leen-
dertse, J. J. "A Tidal Survey for a Model
of an Offshore Area." (See complete entry
in Section VII.)

Walther, A. W. "Hydraulic Research in the
Oosterschedle Estuary." (See complete
entry in Section I.)

Ward, G. H., Jr. 1982. "Pass Cavallo,
Texas; Case Study of Tidal-Prism Capture,"
Journal, Waterway, Port, Coastal and Ocean
Division, ASCE, 108(WW4):513-525.

Pass Cavallo was until 1963 the only per-
manent inlet for the Matagorda Bay System,

and has not been stabilized or protected
in any way. In 1963, a deep-draft ship
channel was constructed to provide access
from the Gulf of Mexico, for which the
Entrance Channel was dredged across Mata-
gorda Peninsula (8,000 ft = 5.5 km) up the
coast from the Pass. This land cut proved
to be scour unstable, enlarging spontane-
ously to depths on the order of 50-60 ft
(15-18 m) and widths on the order of
1,000 ft (300 m). Current measurements in
Pass Cavallo prior to the creation of the
land cut and approximately 10 years after
are analyzed to determine hydraulic char-
acteristics. These indicate that the
Entrance Channel has captured approxi-
mately half of the tidal prism of Pass
Cavallo. From both critical current and
critical stress criteria, the reduction in
current speed in Pass Cavallo associated
with this loss of tidal prism is suffi-
cient to render the Pass shoal unstable,
hence more susceptible to deposition.
References (13 items).

Warnock, J. G., and Tanner, R. G. 1978.
"Selection of Optimum Sites for Tidal
Power Development in the Bay of Fundy,"
Papers Presented at the International
Symposium on Wave and Tidal Energy,
University of Kent, Canterbury, England,
September 27-29, 1978, BHRA Fluid Engi-
neering, Cranfield, Bedford, England,
1:E1-1-E1-22.

The authors describe studies carried out
on behalf of the Bay of Fundy Tidal Power
Review Board to develop realistic designs
and cost estimates for tidal power plants.
Reevaluation of earlier studies, including
tidal characteristics, geology, and exist-
ing technology, showed that optimal
performance would be achieved by using
double-regulated rapid and reaction type
turbine generators, submerged semi-conduit
sluiceways, and a marks-four or similar type.
The eight sites selected by this prelim-
inary analysis were then reduced to three
by an optimization procedure based on com-
parative at-site energy costs, the three
sites being subjected to more detailed
analysis to provide site-specific plant
design and cost data to support a deter-
mination of the competitive status of
tidal power at various levels of installed
capacity. The authors conclude that it is
possible to justify development at two
sites of 1,100- and 4,000-MW capacity; the
delivered costs of energy should be re-
duced by future refinements in turbine
design and production scheduling. Refer-
ences (5 items).

Weggel, J. R., Roberts, J., and Hagar, J.
1979. "Wave Action on the Savannah Tide
Gates," Coastal Structures 79, A Specialty
Conference on the Design Construction,
Maintenance and Performance of Port and
Coastal Structures, March 14-16, 1979,
Alexandria, Virginia, ASCE, 1:67-92.

To minimize the need for maintenance
dredging in the Front River navigation
channel, the Savannah District, US Army
Corps of Engineers, constructed a series
of 14 tide gates in a tide gate structure
across the Back River. The gates open
during flood tide and allow upstream flow
in the Back River but close during ebb
flow and force all of the tidal discharge
out through the Front River thereby flush-
ing the navigation channel. References
(2 items).

SECTION VI. MODELING AND OTHER LABORATORY EXPERIMENTS

Physical and mathematical model studies and other controlled experiments connected with any phase of tidal hydraulics. Investigations of theoretical aspects, studies for improvement or regulation at specific localities, theory of physical model design and operation, physical model appurtenances, and types of problems susceptible of model analysis.
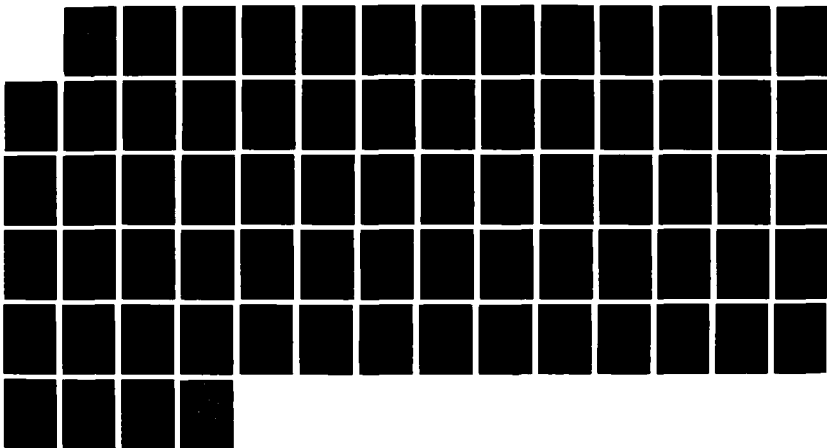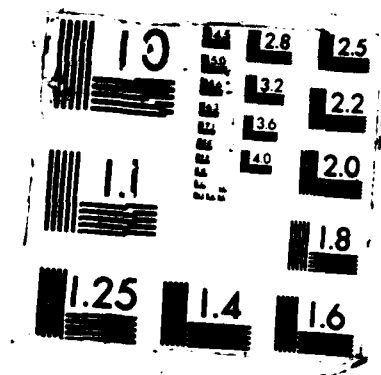
Abbott, M. B., Schrøder, H., and Warren, I. R. 1978. "Modelling of the Salinity Intrusion in the Sound Between Denmark and Sweden," Proceedings, International Conference on Water Resources Engineering, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:195-207.

A model simulating two-layer flow in two horizontal dimensions has been developed and calibrated. The extensive amount of field data available allowed a close examination of the various methods of representing interfacial shear stress and interfacial mixing (entrainment and/or vertical diffusion) in a two-layer model. The model has been applied to an investigation of the salinity intrusion in the sound between Denmark and Sweden. The effect of a tunnel which may be built across the Sound on the seabed was included in the investigation. The tunnel will reduce the flow in the lower saline layer, which may have had a detrimental effect on the ecological system in the sound. Both subcritical and supercritical flow situations were investigated. References (3 items).

Ali, A. 1982. "A Comparison Between Vertically Integrated and Multilevel Models of Tidal Dynamics in Channels," Estuarine, Coastal and Shelf Science, 14(4):405-419.

A comparative study of vertically integrated and multilevel river models has been made numerically. The multilevel model is a simplified version of the earlier model developed by Johns (1978). The study indicates the extent to which vertically integrated models are a reasonable substitute for the multilevel models. The effect of fresh water on tidal elevation and current in a river is also considered. References (11 items).

Ambrose, R. B., Jr., and Roesch, S. E. 1982. "Dynamic Estuary Model Performance," Journal, Environmental Engineering Division, ASCE, 108(EE1):51-71.

Applications of the Dynamic Estuary Model (DEM) to both the Delaware and Potomac estuaries by the Environmental Protection Agency during the 1970s are summarized and evaluated. Methods for calibrating, refining, and validating this model, and statistics for evaluating its performance are discussed. Following a brief description of DEM, observed and predicted hydrodynamic, mass transport, and water quality variables are statistically analyzed for the Delaware and Potomac applications. Weaknesses in the model and in these applications are identified. Model performance is evaluated for its usefulness to investigations of wastewater management alternatives in tidal rivers and the upper reaches of estuaries. Results indicate that the DEM can describe real-time

longitudinal tidal hydraulics with good accuracy for relatively steady flow periods and can predict longitudinal mass circulation with sufficient accuracy for well-mixed, far-field conditions. The DEM can adequately predict relative differences in water quality to be expected from incremental wastewater management alternatives, but more realistic kinetic structures are needed to predict water quality response to large changes in waste load characteristics. References (17 items).

Anwar, H. O., and Weller, J. A. "An Experimental Study of the Structure of a Freshwater-Saltwater Interfacial Mixing." (See complete entry in Section III.)

Awaji, T. "Water Mixing in a Tidal Current and the Effect of Turbulence on Tidal Exchange through a Strait." (See complete entry in Section I.)

Bartholdy, J. 1984. "Transport of Suspended Matter in a Bar-Built Danish Estuary," Estuarine, Coastal and Shelf Science, 18(5):527-541.

The river Varde Å discharges into the bay of Ho Bugt on the western coast of Jutland forming a small, bar-built estuary. This paper deals with tidal fluxes of water and sediment in the Varde Å estuary. The inflowing water at flood tide is part of a turbidity maximum in the northern part of the bay. At high tide slack water the suspended material deposits inside the estuary. During ebbtide it is resuspended, and the estuary bottom is washed clean coinciding with the influx of relatively pure fresh water from the drainage area. From one station in the estuary mouth, current velocities and concentrations of suspended material have been measured during 10 tidal periods covering all four seasons. It is shown how these data can be used in a quantitative calculation of the transport of water and suspended material through the cross section of study. A model has been formulated which--based on half-tidal periods--quantified the transport of water and suspended material through the estuary mouth. The model is calibrated on the basis of measurements made during the above-mentioned 10 tidal periods. The rather small number of measurements is to some extent compensated for by a carefully prearranged selection of tidal periods. The model is discussed in relation to the prediction of net suspended transport through the estuary mouth in different weather and tidal situations. References (17 items).

Basu, A. N. 1978. "Composite Mathematical Model of Saptamukhi River System Including Outfall Channels for Studying the Effect of Closure," Proceedings, International Conference on Water Resources Engineering,

Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:297-313.

The effects of a contemplated closure of river Saptamukhi upstream of Namkhana Creek junction have been investigated by tidal computation in a composite mathematical model of the Saptamukhi system comprising unidimensional flow in the estuary portion and two-dimensional flow in the outfall channels. Solution of the basic tidal equations by harmonic method has been obtained on a computer. After achieving simulation of the prototype tidal phenomena, both immediate and long-term effects of the closure have been investigated. The study reveals that the total combined maximum discharge of the east and west outfall channels at the downstream end, which reduces by about 7 percent immediately after closure, undergoes a further reduction by about 24 percent of the existing maximum discharge due to siltation. The maximum velocities in the reaches immediately downstream of the closure would be low. Therefore, dredging would be necessary to maintain navigability of these reaches. References (5 items).

Battisti, D. S., and Clarke, A. J. "A Simple Method for Estimating Barotropic Tidal Currents on Continental Margins with Specific Application to the M_2 Tide off the Atlantic and Pacific Coasts of the United States." (See complete entry in Section I.)

Berndt, D., et al. 1980. "Artificial Roughness in Physical Models of Estuaries for Storm Surge Investigations," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2495-2503.

One of the characteristics of the North Sea between the British Isles, The Netherlands, Germany, and Denmark is the occurrence of heave storm surges especially in autumn and winter with heights of about 4 m above spring high water. Coastal areas and especially the estuaries of the tidal rivers are hit by these storm surge events. The mean tidal range at the German coast comes to about 3 m with relatively low daily and semimonthly inequalities of less than 0.5 m. Within the framework of long-term developments of the navigation channels of the estuaries as well as of the storm surge protection works, physical model tests had to be carried out in order to predict the influences of such measures on the storm surge heights to be expected. It was possible to find out the reason for the difficulties in reproducing storm surge events in physical models of estuaries with wide flat areas. The importance of the necessity of not underestimating the influence of flat areas on the simulation of storm

tides was pointed out. On this basis a new method for such investigations including the consideration of the influence of local winds was developed and successfully applied. By means of momentum jets and pendulum strips it was possible to achieve a good agreement with natural courses of storm surges. Finally it should be pointed out that up to now the idea for this new method and its application exists for one physical tide model after some basic tests in a plume. However, further research is needed, in particular to modify the facilities of this new development. Reference (1 item).

Bottin, R. R., Jr., and Earickson, J. A. 1984. "Buhne Point, Humboldt Bay, California, Design for the Prevention of Shoreline Erosion; Hydraulic and Numerical Model Investigations," Technical Report CERC-84-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Two numerical models and two physical models were used to investigate the effects of proposed improvement plans with respect to shoreline erosion at Buhne Point, Humboldt Bay, California. Initially, a numerical tidal circulation model was used to determine the tidal current field adjacent to Buhne Point. Maximum flood and ebb tidal currents were identified and used as test conditions for the physical models. A 1:100-scale physical model of central Humboldt Bay included the jettied entrance to the bay, approximately 18,000 lin ft of shoreline inside the bay (including Buhne Point), and underwater contours throughout the central portion of the bay and the area between the jetties. This model was used to determine the wave climate (angle of wave fronts and wave heights along these fronts) in the vicinity of Buhne Point for a series of incident wave conditions and directions (waves propagated through the Humboldt Bay entrance) and for various water levels and tidal flow conditions. A 30-ft-long wave generator, an Automated Data Acquisition and Control System (ADACS), and a model circulation system were utilized in model operation. The output conditions obtained from the 1:100-scale physical model were input into a 1:50-scale physical model of Buhne Point where the effectiveness of various structures proposed for shore protection was evaluated. This model reproduced approximately 9,200 lin ft of shoreline in the Buhne Point area and the immediate underwater contours in Humboldt Bay and utilized an 85-ft-long curved wave generator, a model circulation system, and crushed coal tracer material in model operation. Through the use of a numerical sediment transport model of Humboldt Bay, the effects of the optimum improvement plan developed from the 1:50-scale physical

model on conditions (sediment movement, tidal flushing, etc.) in other areas in the bay (areas not included in the physical models) were determined. The numerical tidal circulation model provided the tidal current field adjacent to Buhne Point for existing (1983) conditions and for the optimum improvement plan (Plan 3D). Based on the results of this model investigation, it was concluded that changes in tidal current velocities and flow patterns will be minimal due to the proposed improvements. The 1:100-scale physical model of central Humboldt Bay provided the wave front and wave heights along the front in the vicinity of Buhne Point for test waves for five water levels and from three directions. Based on the results of this model investigation, it was concluded that: (a) regardless of the direction of incident wave approach from the Pacific Ocean, the angle of the wave front in the vicinity of Buhne Point remains essentially the same; (b) test waves from northwest (approaching through the Humboldt Bay jettied entrance almost directly up the axis of the channel) result in significantly larger wave heights in the vicinity of Buhne Point, as opposed to test waves from north and/or west. The 1:50-scale physical model of Buhne Point was used to determine the causes of erosion at the point and the effectiveness of various structures proposed for shore protection. Based on the results of this model investigation it was concluded that: (a) Wave energy approaching Buhne Point from the jettied entrance to Humboldt Bay resulted in erosion of the original spit. Sediment eroded from the eastern portion of the shoal and migrated westerly where it entered the navigation channel. (b) For the originally proposed improvement plan (Plan 1), erosion occurred at the eastern portion of the fill with accretion against the proposed groin. Eventually, material migrated around the groin head and toward the navigation channel. (c) For the proposed groin plan (Plan 2), the shoreline did not remain stable. Sediment eroded at the eastern portion of the fill and accreted against the originally proposed westernmost groin. Material eventually migrated around the groin head and toward the navigation channel. (d) Sediment eroded in the lee of the shore-connected breakwater with the +7-ft elevation (Plan 3) for normal high-tide conditions (water el +6.7 ft). (e) Sediment remained stable in the lee of the shore-connected breakwater with the +10-ft elevation (Plan 3A) for normal tide conditions (water el +6.7 ft), but erosion occurred for extreme high-tide conditions (water el +9.5 ft). (f) Sediment remained stable in the lee of the shore-connected breakwater with the +13-ft elevation (Plans 3C and 3D) for all tide conditions (including the extreme +9.5-ft

conditions). (g) A reverse curve in the shore-connected breakwater where it originates from the existing Buhne Drive revetment (Plan 3D) minimized wave convergence and runup in this area. (h) A 25-ft-wide fill (el +12 ft) in the lee of the shore-connected breakwater and adjacent to the existing Buhne Drive revetment (Plan 3D) prevented transmitted wave energy from running up on Buhne Drive for all test conditions. (i) Erosion occurred in the lee of the offshore breakwater plans with the +13-ft elevation (Plans 4 and 4A) for extreme high-water conditions (water el +9.5 ft). When the fill was depleted, wave energy transmitted through the revetment adjacent to Buhne Drive and onto the roadway. (j) A 1,000-ft-long offshore breakwater with the eastern 425-ft portion installed at a crest elevation of +16 ft (Plan 4B) was required to stabilize the fill in the lee of the structure. Slight erosion of the fill at its eastern limit occurred prior to stabilization, but wave runup onto Buhne Drive did not occur. (k) A 1,200-ft-long offshore breakwater with the eastern 625-ft portion installed at a crest elevation of +16 ft (Plan 4F) resulted in a stable shoreline in the lee of the structure with no erosion. (l) Sediment stabilized and remained in the area between the structures with the 425-ft-long extension of the original groin for all test waves, tidal currents, and water levels. (m) Small amounts of sediment penetrated through the voids of the rubble groin head at the downcoast (western) end of the fill for extreme high-tide conditions (water level +9.5 ft). (n) Of the improvement plans tested, Plan 3D was regarded as the optimum, considering shore protection and construction costs. The shoreline remained stable for all test waves, tidal flow conditions, and water levels. The numerical sediment transport model (CELC3D) provided estimates of sediment movements due to residual tidal currents and wave interactions, for both the existing (1983) conditions and for improvement Plan 3D. From this investigation, it was concluded that no new sediment transport patterns are induced by the optimum improvement plan (Plan 3D). References (26 items).

Bowman, M. J., et al. 1983. "Shelf Fronts and Tidal Stirring in Greater Cook Strait, New Zealand," Oceanologica Acta, 6(2):119-129.

Numerical tidal simulations and hydrographic data from two austral summer (January 1980 and 1981) cruises were used to study tidal mixing variations, upwelling and circulation in the shelf seas of central New Zealand. Four classes of fronts were identified: the Cape Farewell upwelling front, two tidal mixing fronts

spanning Cook Strait, a plume front bounding an intrusion of subtropical water driven into Cook Strait from the northwestern approaches, and a shelf break front east of Cook Strait. Bulk stratification correlated well with the h/u^3 stratification index (r ~ 0.6); potential energy deficit and surface to bottom temperature differences less well (r ~ 0.53 and 0.38, respectively); potential energy deficit showed some tendency to follow the bathymetry. A critical value of the stratification index s ~ 1.5 (c.g.s. units) appeared to separate mixed from stratified water at the tidal mixing fronts, in good agreement with results obtained in other semi-enclosed shelf seas in temperate latitudes. The data suggest that prevailing patterns of stratification can be considerably modified by the variable and often strong winds that frequent the region. References (35 items).

Breusers, H. N. C., and van Os, A. G. 1981. "Physical Modelling of the Rotterdamse Waterweg Estuary," Publication No. 249, Delft Hydraulics Laboratory, Delft, The Netherlands.

The model of "Europoort" and the "Rotterdamse Waterweg" estuary has a long history. Improvement in knowledge of the hydrodynamic phenomena and technical possibilities has resulted in major changes in the model and its operation. This paper describes both the evolution and the final state of the model, together with the related aspects of calibration, verification, operation, and data processing. References (13 items).

Brocard, D. N., and Hsu, S.-K. 1981. "Combined Near- and Far-Field Water Quality Predictions in an Estuary," Proceedings, Specialty Conference, Water Forum '81, San Francisco, Calif., August 10-14, 1981, ASCE, I:375-382.

This paper describes a mathematical modeling technique for predicting water quality parameters associated with effluent discharges in a tidal estuary with flow reversals. Because of these reversals, the ambient river water used to dilute the effluent contains previously discharged substances or heat, thereby producing a background concentration or temperature rise over the near-field plume. Due to the large distances traveled by the returning effluent and as a result of the lateral mixing associated with secondary currents during flow reversals, the background rise, while variable in time, can be assumed to be uniform over the river section. A one-dimensional transient model can, therefore, be used for the determination of the background rise. The near field is dominated by the discharge jet which can be simulated using an integral buoyant jet model including the effects of

ambient currents. Results from the two models are then appropriately superimposed to obtain complete temperature rise predictions. The characteristics of the mathematical models as well as the method used for their superposition are briefly described and the application to an actual site is discussed with emphasis on the results of the intermediate steps and on the utilization of existing measured data to set boundary conditions, estimate parameters, and verify results. References (4 items).

Brown, W. D., and Arellano, E. 1980. "The Application of a Segmented Tidal Mixing Model to the Great Bay Estuary, N.H.," Estuaries, 3(4):248-257.

Measurements show that in general salt is vertically well mixed everywhere in the Great Bay Estuary, New Hampshire, except near the river entrances at the head of the estuary. Dyer and Taylor's (1973) modified version of Ketchum's segmented tidal prism model has been applied to the Great Bay Estuarine System in order to predict high- and low-water salinity distribution for a specified river flow. The theory has been modified here to account for the mixing which occurs at the junction of two branches of an estuary. The mixing parameter, which in this model is related to the tidal excursion of water in the estuary, has been determined for different segments in the estuary on the basis of a comparison between predictions and a comprehensive data set obtained for a low river flow period. Using a mixing parameter distribution based on the low river flow calibration procedure, the salinity distribution has been predicted for high river flow. The resulting salinity distribution compares favorably with observations for most of the estuary. The corresponding flushing times for water parcels entering at the head of the estuary during periods of low and high river flow is 54.5 and 45.9 tidal cycles, respectively. References (13 items).

Buchak, E. M., and Edinger, J. E. 1982. "User Guide for CE-QUAL-ELV2: A Longitudinal-Vertical, Time-Varying Estuarine Water Quality Model," Instruction Report EL-82-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report is the user guide for a FORTRAN program that permits time-varying hydrodynamic and transport simulations of estuaries. It also includes a summary of the development of this program, with emphasis on the characteristics of estuaries, estuarine boundary conditions, turbulence, and validation tests. CE-QUAL-ELV2, an acronym for the Estuarine Longitudinal-Vertical 2-Dimensional model, consists of the original Laterally Averaged Estuary Model (LAEM) plus the

Water Quality Transport Module (WQTM). The LAEM program was developed for a test application to the Potomac Estuary from the then-current version of the Laterally Averaged Reservoir Model (LARM). The References section of this report lists all the available documents describing the related development of the LARM and LAEM programs. This report contains an overview of the capabilities of CE-QUAL-ELV2; a summary of its theoretical foundation and discussion of the validation tests; a synopsis of estuarine characteristics, including turbulence, with reference to the Patuxent Estuary; and a detailed discussion of the application procedure, again with reference to the Patuxent example. The appendices contain an input data description with examples and user notes for two auxiliary codes. References (53 items).

Butler, H. L. 1978. "Coastal Flood Simulation in Stretched Coordinates," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, I:1030-1048.

Coastal flooding in developed areas can be catastrophic. As an essential element in coastal water level prediction, a two-dimensional numerical model of long period wave behavior is presented. The time dependency is treated implicitly for cost-effective simulation of coastal flooding from hurricane surges or other hydrodynamic phenomena such as extratropical storm surges, tides, tsunamis, etc. An important feature of the model is use of a coordinate transformation in the form of a piecewise exponential stretch. Such a technique permits simulation of a complex landscape by locally increasing grid resolution and/or aligning coordinates along physical boundaries. The model is applied to Galveston Bay, Texas, for storm surge and coastal flooding from Hurricane Carla, 1961. Verification for the Galveston area was accomplished by using physical model data from simulations of free gravity waves (tide and design surge). Subsequent hindcasting of Carla produced good agreement between observed and computed surges with a mean absolute error of 0.18 m for peak elevations. References (19 items).

Butler, H. L. 1983. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 3, Numerical Model Investigation of Plan Impact on the Tidal Prism of Lake Pontchartrain," Technical Report HL-82-2, Report 3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents results pertinent to a detailed investigation of effects of proposed structures in the two major arteries (the Rigolets and Chef Menteur Pass) connecting Lake Pontchartrain with the Gulf of Mexico and the lock/structure system between the lake and the Inner Harbor Navigation Canal (IHNC). The basic approach to simulating the impact of structural alterations on the Lake Pontchartrain tidal prism can be outlined as follows: (a) develop a numerical model of the three-basin system (Lakes Pontchartrain, Borgne, and Maurepas); (b) obtain and analyze field data to aid in calibrating and verifying the lake system model; (c) perform sectional model studies of each pass to provide descriptions of structure hydraulic characteristics to the numerical tidal prism model; and (d) calibrate and verify the tidal prism model and test plan impact under mean, spring, and neap tide conditions. Preliminary calculations with these tide conditions indicated difficulty in assessing the true impact of the hurricane protection plan on the tidal prism of Lake Pontchartrain. References (14 items).

Butman, B., et al. "An Upper Bound for the Tidally Rectified Current at One Location on the Southern Flank of Georges Bank." (See complete entry in Section I.)

Carton, J. A. "The Variation with Frequency of the Long-Period Tides." (See complete entry in Section I.)

Chatham, C. E. 1977. "Los Angeles Harbor and Long Beach Harbor: Design of the Hydraulic Model," Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Long Beach, Calif., March 9-11, 1977, I:47-64.

This paper describes the design of a hydraulic model and related equipment constructed to experimentally investigate the effects of proposed expansions of Los Angeles and Long Beach Harbors. In order to ensure proper reproduction of waves in the model, it was necessary to conduct an extensive study of (a) wave refraction for wave periods of 15 sec to 6 min; (b) energy transmission through the breakwaters; (c) diffraction through the harbor entrances; (d) reflection from the offshore topography and from harbor boundaries; (e) wave filters and absorbers; (f) model wave-height attenuation; (g) wave generators; and (h) model data acquisition and analyses. After consideration of the various items described above, it was concluded that valid data could be obtained from the model for a vertical scale of 1:100 and a horizontal scale of 1:400 (distortion of 4.0). The model, completed in July 1973, reproduces the entire harbor area, the shoreline from Point Fermin to Huntington Beach, and underwater contours out to -300 ft. The total model area is 44,000 sq ft representing the largest wave model ever constructed in the United States. Tides are mechanically reproduced by exchanging water between the model

headbay and a water storage sump by means of a system of pumps, valves, and pipes. Waves are generated by a 210-ft-long electrohydraulic wave generator composed of 14 individual sections (each 15 ft long) which can be positioned to reproduce curved wave fronts and controlled by automation techniques to generate waves of variable heights and periods. Due to the extreme complexity and large size of the Los Angeles and Long Beach Harbors model, as well as the volume of model data to be collected, an automated data acquisition and control system (ADACS) with supporting software for data analyses has been designed and assembled. References (18 items).

Chelton, D. B., Jr. 1980. "Low Frequency Sea Level Variability Along the West Coast of North America," Ph. D. Dissertation, University of California, San Diego.

The use of linear statistical estimators to examine dynamical models is discussed, and the importance of using multiple input statistical models rather than a series of single input models is emphasized. A methodology is described for determining the effects of statistical uncertainty in both time and frequency domain multiple input statistical models. These methods are then used to examine 30 years of nonseasonal tide gage and steric sea level data along the west coast of North America. The objective is to explore the nature and causes of nearshore oceanic variability over short-term climatic time scales of months to years. After the tide gage records are corrected for the inverse barometric effects of atmospheric pressure, it is found that there is close agreement between the two measures of sea level at frequencies less than 1 cycle/ year. At higher frequencies the steric sea level variations measured relative to 500 db are, on average, only about one half as large as high-frequency tide gage sea level variations. Analyzing tide gage records from Alaska to Mexico, it is found that low-frequency sea level fluctuations are closely related to El Niño occurrences in the eastern tropical Pacific and that these El Niño events appear to propagate poleward with phase speeds of around 50 cm/sec. Higher frequency variations are primarily the result of forcing by the local atmospheric pressure but the response is generally found to be greater than inverse barometric (1 cm/mb). Much of the remaining high-frequency sea level variability is the result of forcing by the wind field. The longshore component of wind stress generally forces a larger sea level response than the onshore component, but the important dynamical aspects of the wind field generally appear to be basinwide rather than local. The

dominant signal in residual sea level after removing the atmospheric and oceanographic effects as determined from the statistical models represents long-term trends over the 30-year record length. The trends at the lower latitude stations are attributed to the eustatic rise in sea level from melting glaciers. The drop in measured sea level at the higher latitudes has generally been attributed in the past to an apparent drop due to isostatic rebound of the earth's crust from the most recent glaciation. However, it is shown that part of this drop may reflect a true change in sea level due to cooling of the surface waters in the North Pacific over the last 30 years. Analyzing steric sea level records off California, it is found that the hydrographic data are quite noisy but that empirical orthogonal function analysis is an effective method for extracting the large-scale "signal" from the mesoscale "noise." Most of the nonseasonal upper ocean variability is restricted to the upper 200 m but located subsurface at about the depth of the permanent thermocline. The dominant signal in nonseasonal nearshore oceanic variability is a very large-scale low-frequency variation in the flow with biological effects off the coast of California similar to those of Southern Hemisphere El Niño events off the coast of Peru and southern Ecuador. Over shorter time scales the wind stress curl appears to be an important aspect of large-scale dynamics of the California Current. In addition, another mode of high-frequency variability with very short longshore coherence is isolated that resembles the response expected for coastal upwelling driven by the longshore wind stress. References (73 items).

Chiang, W.-L., and Lee, J.-J. "Tide-Induced Currents in Harbors of Arbitrary Shape." (See complete entry in Section I.)

Chu, W.-S., and Willis, R. 1981. "Mathematical Modeling of Humboldt Bay," Proceedings, Specialty Conference, Water Forum '81, San Francisco, Calif., August 10-14, 1981, ASCE, I:375-382.

The objective of this paper is to present the results of hydrodynamics and water quality investigation of Humboldt Bay, California. Humboldt Bay is a unique estuarine system with a variety of fishery and marine resources. The bay is also a major commercial shipping and fishing port. The motivation for the study is to develop a clearer understanding of the hydrodynamic and water quality variations occurring within the bay, and, in contrast to previous studies, to provide a practical, rational methodology for environmental planning. References (7 items).

Chu, W.-S., and Yeh, W. W-G. 1980. "Parameter Identification in Estuarine Modeling," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2433-2449.

Parameter Identification (PI) algorithm is an optimization procedure that systematically searches the parameters embedded in a mathematical model. These parameters are not measureable from a physical point of view. The optimization is based on the minimization of a selected norm of the differences between the solution of the mathematical model and scattered observations collected from the system. This study deals with PI in a two-dimensional vertically averaged estuarine salinity model. The salinity transport equation is coupled with the hydrodynamics equations. The coupled relationship introduces extra density terms in the hydrodynamics equations, which must be solved simultaneously with the transport equation. References (18 items).

Chu, W.-S., Yeh, W. W-G., and Kristof, R. C. 1981. "Mathematical Modeling and Parameter Identification in a Two-Dimensional Estuary: Case Study of the Hydraulic Model of the San Francisco Bay and Delta," Contribution No. 183, California Water Resources Center, University of California, Davis, Calif.

This report presents a study of conjunctive use of mathematical and physical models for estuarine hydrodynamics and salinity transport simulation. Two sets of mathematical models are developed which are capable of simulating both the intertidal and intratidal conditions as represented by an existing, well-calibrated hydraulic model. Suisun Bay, a significant portion of San Francisco Bay, is selected as a study area for this project. Data collected from the physical model which contain relatively less noise are used to calibrate the mathematical models by an automatic optimization routine. The calibrated parameters are used for verification using a different set of data collected from the hydraulic model. Both calibration and verification compare favorably with observations. This report identifies a number of discrepancies in the general use of both mathematical and physical models based on the findings of this study. The problem of optimization in parameter identification with noisy data is also discussed. The prospect of parameter identification with prototype data is summarized, along with the recommendations for future use of similar algorithms. References (47 items).

Coastal Sediments '77, Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE. (See complete entry in Section II.)

Committee on Tidal Hydraulics, Corps of Engineers, US Army. 1980. "Evaluation of Numerical Storm Surge Models," Technical Bulletin No. 21, Office, Chief of Engineers, Washington, DC.

Federal services that minimize loss of life and property due to tropical hurricanes include forecasts and flood warnings by the National Weather Service, design of protective works by the US Army Corps of Engineers, and the establishment of flood insurance rates by the Federal Insurance Administration. Each agency employs mathematical models of hurricane events for simulating impacts. Because of the different concerns of these agencies, their models have evolved in different ways and are applied with different input data, and apparent disparities have appeared. The Office of the Chief of Engineers (OCE) expressed concern for this situation and requested that the Committee on Tidal Hydraulics conduct an evaluation of the existing models. OCE specifically requested that the Committee determine the needs for further development of mathematical models by the Corps, the models most suitable for Corps applications, and if the models perform comparably, the most cost-effective models. Evaluation was accomplished by having each modeling group separately exercise its models for selected past events and by comparing the model outputs with each other and with observed water elevations. The modeling groups were those at the National Weather Service, the Coastal Engineering Research Center, the Waterways Experiment Station, and Tetra-Tech, Inc. Open-coast storm surge models were evaluated; then inland flooding models were evaluated using as input one of the open-coast model results. Each model tested included features that offered important advantages. Further, the models were continually evolving to include improved descriptions of the land and waters and of storms. No one model's predictions consistently gave better comparisons with observed data, however; and it is unlikely that one will be clearly better than the others for Corps purposes. It was found that large uncertainties exist in the quality of water-surface elevation observations, large gaps occur in water elevation and meteorological data during the course of storm events, and the few existing observations are not taken at the most desirable locations. This situation is the most serious impediment found during the study to the development of accurate predictive models. Different procedures for specifying or selecting model input parameters and for calculating storm frequencies can lead to the calculation of widely different return periods for computed surges even when the same hydrodynamic model is used. These procedures are not uniform among the several

agencies. Further improvements of the simulated wind fields are needed, and sensitivity analyses of the models are required in order to extend the usefulness of all of the models to new situations. Specific recommendations are presented for optimizing the value of mathematical models of storm surge and inland flooding for use by the Corps of Engineers. References (27 items).

Connolly, J. P., Armstrong, N. E., and Miksad, R. W. "Adsorption of Hydrophobic Pollutants in Estuaries." (See complete entry in Section IV.)

Cooper, C. K., and Pearce, B. R. 1977. "Development of a Simple Numerical Model to Calculate the 3-D Structure of Currents in Coastal Areas Using a Depth Varying Eddy Viscosity," Proceedings, Seventeenth Congress of the International Association for Hydraulic Research; Hydraulic Engineering for Improved Water Management, 15-19 August 1977, Baden-Baden, Federal Republic of Germany, 2:141-148.

Most previous three-dimensional circulation models have assumed the vertical eddy viscosity to be a constant through the water depth. Fundamental arguments are briefly presented demonstrating the lack of theoretical and physical justification for such an assumption. The formulation of a three-dimensional numerical model using a depth-varying vertical eddy viscosity is presented. A functional form for the velocities in terms of a cosine series of unknown amplitude is assumed. The Galerkin weighted residual approach is used to transform the nonlinear Navier Stokes equations into a set of linear PDE's in terms of the unknown amplitudes. These equations are solved using a simple finite-difference scheme. The model is applicable to coastal areas and lakes where winds and tides are the dominant driving forces. Model results include a continuous functional form for the vertical variation of the horizontal velocities. Computer time and space requirements are of the same order as for existing two-dimensional vertically averaged numerical models. References (6 items).

Daifuku, P. R., and Beardsley, R. C. "The K_1 Tide on the Continental Shelf from Nova Scotia to Cape Hatteras." (See complete entry in Section VIII.)

Davesne, M., and Graff, M. "Mathematical and Physical Models for Navigation in Approach Channels and Harbour Entrances." (See complete entry in Section V.)

Davies, A. M. 1978. "Role of 2D and 3D Models in JONSDAP '76," Proceedings, Sixteenth Coastal Engineering Conference,

August 27-September 3, 1978, Hamburg, Germany, ASCE, I:1085-1103.

This paper describes how a two-dimensional numerical model of the North Sea was used to determine optimum positions for the deployment of offshore tide gages during the JONSDAP '76 oceanographic exercise. A three-dimensional model of the Northwest European Shelf is also described. Using this model, the three-dimensional distribution of the M_2 tidal current over the shelf has been computed. This model has also been used to compute the wind-induced circulation of the North Sea for the INOUT period of JONSDAP '76.

Dennis, W. A., Lanan, G. A., and Dalrymple, R. A. 1978. "Case Studies of Delaware's Tidal Inlets: Roosevelt and Indian River Inlets," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1282-1301.

Studies were undertaken to document the past and present characteristics and trends of Delaware's two major tidal inlets, Roosevelt and Indian River Inlets. It was found that both inlet complexes are effective sediment traps causing considerable downdrift erosion. The major mechanism by which sand enters Indian River Inlet is by overtopping the impounded south jetty. At Roosevelt Inlet sediments are readily transported past the severed steel sheet pile jetties. The results of a one-dimensional hydraulic model, as well as field measurements, predict the presence of a mean southerly flow through the canal and bay system which connects these two inlets. This flow is shown to have a substantial effect on the behavior and stability of these entranceways, causing major asymmetries on the depositional patterns at each location. Roosevelt Inlet was found to have a strong tendency to trap sediment within its throat, whereas Indian River Inlet, on the opposite end of the system, was found to retain large quantities of sand on its developing ebb tidal shoal. References (15 items).

Devine, M. 1983. "Some Features of the Dynamic Structure of a Deep Estuary," Estuarine, Coastal and Shelf Science, 16(3):271-289.

A boundary layer formulation for the dynamic structure of a deep estuary is developed. Cross-stream averages are used, but the boundary layer structure is shown to depend on the cross-stream geostrophic constraint. A similarity transformation and a weighted residual method are used to derive an approximate solution for the velocity and salinity structure of the upper layer. This solution indicates that, in the central regime of the estuary, outflow extends through the entire halocline.

Inflow takes place in a much less stratified lower layer, and mass exchange between the layers is by upwelling. This structure is modified in the outer regime of the estuary, where mixing between the layers develops, and in the inner regime, where a sharp halocline develops and where the dynamics are dominated by river runoff. The implications of the dynamics for the flushing process and for pollutant movement and dispersion are discussed. References (28 items).

DeWall, A. E., et al. "Inlet Processes at Eel Pond, Falmouth, Massachusetts." (See complete entry in Section II.)

Diamante, J. M., et al. "Tidal and Geodetic Observations for the SEASAT Altimeter Calibration Experiment." (See complete entry in Section VII.)

Dronkers, J. "Longitudinal Dispersion in Shallow Well-Mixed Estuaries." (See complete entry in Section I.)

Druery, B. M. "Estuarine Response to Dredging in the Tweed River, Australia." (See complete entry in Section V.)

Druery, B. M., and Nielsen, A. F. "Mechanisms Operating at a Jettied River Entrance." (See complete entry in Section II.)

Duwe, K. C., and Hewer, R. C. 1982. "A Semi-implicit Tidal Model for Wadden Sea Areas" ("Ein semi-implizites Gezeitenmodell für Wattgebiete"), Deutsche Hydrographische Zeitschrift, 35(6):223-238 (In German).

A new numerical method for the simulation of water movements in Wadden Sea areas is presented. It is based on a semi-implicit algorithm that has been generalized to cope with shallow water problems and falling-dry processes. The method is not bound by the Courant-Friedrichs-Lewy stability criterion. A comparison of model calculations of the tidal movements in the Heverstrom with results derived by a traditional explicit model shows that besides considerable computer time savings, marked qualitative improvements of the simulation are achieved. References (8 items).

Edinger, J. E., and Buchak, E. M. 1981. "Estuarine Laterally Averaged Numerical Dynamics: The Development and Testing of Estuarine Boundary Conditions in the LARM Code," Miscellaneous Paper EL-81-9, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The longitudinal and vertical hydrodynamics and transport in stratified water bodies as formulated for the Corps of Engineers Laterally Averaged Reservoir Model (LARM) have been transformed to estuaries by development of appropriate boundary conditions. The resulting computational code Laterally Averaged Estuary Model (LAEM) is tested on the Potomac River estuary for a short period of time with intensive field data. The estuary problem was formulated in terms of spatially varying geometry, a time-varying tide height and salinity distribution at the mouth, and freshwater inflow. The LAEM code was found to reproduce overall estuarine dynamics including tide heights, tide phase shifts, and salinity distributions. In addition, detailed time-varying vertical velocity profiles were produced to a high degree of resolution. Detailed results of the model including the distribution of vertical velocities and turbulent dispersion coefficients were compared to those expected for a coastal plain estuary with favorable agreement. References (9 items).

Elahi, K. Z., and Sündermann, J. "The Wind-Driven Circulation in the Northern Arabian Sea." (See complete entry in Section I.)

Elsinger, R. J., and Moore, W. D. "^{226}Ra and ^{228}Ra in the Mixing Zones of the Pee Dee River-Winyah Bay, Yangtze River and Delaware Bay Estuaries." (See complete entry in Section IV.)

Everts, C. H. "Design of Enclosed Harbors to Reduce Sedimentation." (See complete entry in Section V.)

Falconer, R. A. 1983. "Mathematical Model Study of Mass Transport in Harbours," Dock and Harbour Authority, 63(748):343-347.

This paper describes the details and application of a mathematical model to determine the mass transport and time average momentum flux into a harbour or coastal basin as a result of a tidal inflow. In a study for the British Transport Docks Board the model has been applied to Royal Dock Basin, Grimsby, to give an indication of the likely changes in the mass inflow resulting from changing the characteristics of the boundary geometry and the bed topography. Based on the assumption that a reduced mass inflow across the entrance would lead to a reduction in the sediment volume transported into the basin on the flood tide, the two main engineering conclusions arising from this study were as follows: (a) making the East Pier a solid wall would reduce the mass inflow and the time average momentum flux across the entrance, and hence probably the sediment influx and uniformity of deposition across the basin; and (b) the effect of dredging the proposed area would only marginally affect the mass inflow and momentum flux across the entrance. References (n items).

Falconer, R. A. 1980. "Modelling of Planform Influence on Circulation in Harbours," Proceedings, Seventeenth Coastal

Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2726-2744.

A two-dimensional numerical model has been developed which is capable of predicting the tidal water elevations, depth-averaged velocity components, and horizontal concentration distributions in narrow entranced harbours and marinas. Particular attention has been paid to the numerical treatment of the convective accelerations where, as a result of narrow harbour entrances and the general nature of planform geometries, the resulting highly nonuniform flow fields can readily lead to nonlinear instabilities and unstable numerical solutions. In order to check the validity of the numerical results, a comprehensive study was carried out to compare, with scaled laboratory model studies, the predicted tidal velocity fields and flushing characteristics for a number of rectangular harbours of constant planform area but different length to breadth ratios. The experimentally measured average per cycle exchange coefficients and the observed mean water level pathlines agreed reasonably well with the corresponding numerically predicted exchange coefficients and depth-averaged velocity fields. The results of both the numerical and laboratory model studies confirmed conclusively that the maximum gross flushing characteristics occurred within a rectangular harbour when the length to breadth ratio was close to unity. Also, further tests showed that the insertion of impermeable barriers as a possible means of increasing the flushing efficiency proved to be unsatisfactory. References (9 items).

Fandry, C. B. 1981. "Development of a Numerical Model of Tidal and Wind-Driven Circulation in Bass Strait," Australian Journal of Marine and Freshwater Research, 32(1):9-29.

The initial stages of the development of a numerical model to investigate the effects of wind and tidal forcing on the sea-surface height distribution and currents within Bass Strait are described. The hydrodynamical model is based on depth-averaged equations and incorporates the effects of the earth's rotation and variations in bottom topography. Numerical experiments have been performed with the model to determine the response of Bass Strait to two separate forcing mechanisms: stationary fields of uniform wind stress suddenly imposed over the sea surface, and tidal heights specified along the open-sea boundaries of the model. The results of these experiments are presented and discussed, the principal conclusions being that the maximum tidal currents generated are generally larger than those generated

by the wind, and that variable bathymetry is a major influence on the flow. Furthermore the tidal motion may be characterized by two Kelvin waves travelling in opposite directions through the strait. References (27 items).

Fandry, C. B. 1983. "Model for the Three-Dimensional Structure of Wind-Driven and Tidal Circulation in Bass Strait," Australian Journal of Marine and Freshwater Research, 34(1):121-141.

Earlier models of the circulation in Bass Strait have been extended to include vertical structure. Time-dependent circulation fields in Bass Strait, induced by wind driving at the surface and tidal oscillations along open-sea boundaries, are computed at a number of selected depths. The original two-dimensional model is combined with an analytical solution of the Ekman equations, which at each grid point provides an expression for the time-dependent flow at any depth in terms of a convolution integral over the sea-surface slope and wind stress. This model should be applicable to winter conditions when the strait is well mixed vertically and hence the dynamical effects of density stratification negligible. The predicted wind-induced circulation fields are highly depth dependent, with equilibrium surface currents in the central Bass Strait basin flowing in a direction approximately 45 deg to the left of the wind. At lower levels, currents are controlled by pressure gradient forces due to the sea-surface slope and friction. Significant upwelling and downwelling motions along the Victorian and Tasmanian coastlines can be inferred from these circulation fields. In the deep water off the continental shelf, currents in the upper 100 m are dominated by the (Ekman) drift current which rotates in an anticlockwise direction with increasing depth, such that the wind drift at the surface is accompanied by a measure of return flow at depth. Tidal currents are predicted in the absence of wind stress, but include the effects of bottom topography. Considerable variation with depth is found and the distinctive features are explained in terms of the relative importance of Coriolis force, bottom friction, and water depth. Comparison with the few existing observations reveals that the present model is producing realistic results. References (14 items).

Fischer, H. B. "The Effect of Estuarine Circulation on Pollution Dispersal." (See complete entry in Section I.)

Fischer, H. B., et al. Mixing in Inland and Coastal Waters. (See complete entry in Section I.)

Fischer, K. 1978. "Numerical Salinity In-
trusion Models," Proceedings, Interna-
tional Conference on Water Resources
Engineering, Asian Institute of Technol-
ogy, Bangkok, Thailand, January 10-13,
1978, I:209-218.

Three types of numerical models to simu-
late salinity intrusion into estuaries are
investigated. The simplest is the verti-
cally averaged model with barotropic
forces, where the salinity intrusion must
be simulated by pseudodiffusive mecha-
nisms. The vertically averaged model with
baroclinic forces is only slightly more
complex, gives a better physical picture
of the intrusion process, but breaks down
under certain boundary conditions and bot-
tom topography. The vertically discre-
tized model is much more complicated, but
gives sufficient results under general
conditions and can be applied to strati-
fied and mixed estuaries equally well,
provided that the numerical schemes do not
produce a high amount of numerical dif-
fusivity. References (8 items).

Fischer, K. 1978. "Numerical Tidal-
Salinity Models of the Ems Estuary," Pro-
ceedings, Sixteenth Coastal Engineering
Conference, August 27-September 3, 1978,
Hamburg, Germany, ASCE, III:2840-2854.

A satisfactory salinity intrusion simula-
tion of a mixed estuary has been obtained
by application of a spatially three-
dimensional finite difference model with
three adjustable parameters. The results
of the mathematical model were of a qual-
ity comparable to the results of a hydrau-
lic model. The salinity intrusion was
found to be mainly influenced by the com-
bined action of vertical eddy viscosity
and bottom friction. The vertical eddy
diffusivity parameter could be adjusted
separately and had only influence on the
vertical stratification. The accuracy of
the simulation was limited by the grid
coarseness and artificial diffusion ef-
fects of the numerical method. An analo-
gous simulation by means of a vertically
averaged model with constant horizontal
diffusion parameter gave no acceptable re-
sults. Given a certain range of desired
accuracy in the results (mainly defined by
the accuracy of the available measurement
data), the following model restrictions
were possible to obtain satisfactory
results: (a) constant vertical eddy vis-
cosity, (b) constant bottom friction,
(c) constant vertical eddy diffusivity,
(d) constant salinity at the open bound-
ary, (e) a coarse grid in the horizontal
plane, and (f) only six vertical grid
points. These restrictions made a simula-
tion of the vertical and lateral disper-
sive fluxes possible in the framework of a
model consuming computer time to a still
moderate extent. References (8 items).

Fornerino, M., and Chabert d'Hieres, G.
1982. "Study of M_2 Tidal-Currents in the
English Channel Using the Physical Model
at Grenoble" ("Étude Des Courants De La
Marée M_2 Dans La Manche A L'Aide Du Modèle
Réduit De Grenoble"), Annales Hydro-
graphiques, 10(757):13-31 (In French).

This paper presents a set of maps which
point out M_2 tidal currents main charac-
teristics in the English Channel. These
results were obtained by performing sys-
tematic measurements of tidal currents in
the English Channel physical rotating
model of Grenoble, using a laser Doppler
anemometer. The model was calibrated to
represent the M_2 tide level variations
when the measurements were carried out.
On the other hand, comparisons between the
physical model and the prototype were con-
ducted as far as possible in order to
estimate the precision of tidal current
representation in a physical model. Ref-
erences (10 items).

Foster, D. N., McGrath, B. L., and
Bremner, W. 1978. "Rosslyn Bay Break-
water, Queensland, Australia," Proceed-
ings, Sixteenth Coastal Engineering Con-
ference, August 27-September 3, 1978,
Hamburg, Germany, ASCE, III:2086-2103.

The Queensland Harbours and Marine Depart-
ment conducted a study on possible boat
harbour sites between Yeppoon and Port
Alma on the Central Queensland Coast based
on the following criteria: (a) degree of
protection afforded; (b) tidal access;
(c) degree of maintenance dredging antic-
ipated; (d) capital cost necessary to
establish the harbour and the ability
to construct the harbour in stages;
(e) availability of foreshore area for
development; (f) accessibility by road
transport and to establish amenities; and
(g) availability of suitable quarry mate-
rial. Rosslyn Bay was selected as the
most suitable site and a 105-m rubble
mound rock breakwater was constructed in
1968. The breakwater was extended to
210 m in 1970 and was further extended to
300 m in 1972. In 1976 tropical cyclone
David extensively damaged the breakwater
and harbour facilities. The breakwater
was redesigned following model studies and
reconstruction was completed in May 1978.
This paper discusses damage to the break-
water from wave and surge action, model
studies, and repair of the breakwater.

Funke, E. R., and Crookshank, N. L. 1978.
"A Hybrid Model of the St. Lawrence River
Estuary," Proceedings, Sixteenth Coastal
Engineering Conference, August 27-Sep-
tember 3, 1978, Hamburg, Germany, ASCE,
III:2855-2869.

A hydraulic model of the St. Lawrence
River Estuary had to be partially disman-
tled. In order to reestablish an upstream

boundary for the simulation outside the zone of influence of proposed navigational improvements to the lower estuary, a numerical model of the disbanded upstream river section was dynamically coupled to the remaining hydraulic model. This combination of a numerical and physical model running simultaneously and interactively is referred to as a hybrid model. The implementation of this hybrid configuration was undertaken in part to reactivate the St. Lawrence model as well as to study the feasibility of this approach in preparation for further model studies. References (5 items).

Gardner, G. B., and Smith, J. D. "Observations of Time-Dependent, Stratified Shear Flow in a Small Salt-Wedge Estuary." (See complete entry in Section I.)

Giese, E. H. T. "Use of an Estuary Mobile Bed Model to Investigate Natural Sedimentation Processes." (See complete entry in Section V.)

Godin, G. "The Tide in Rivers." (See complete entry in Section I.)

Gopalakrishnan, T. C., and Machemehl, J. L. 1978. "Verification of a Numerical Flow Model for Carolina Beach Inlet, North Carolina," Verification of Mathematical and Physical Models in Hydraulic Engineering, Proceedings, 26th Annual Hydraulics Division Specialty Conference, University of Maryland, College Park, Maryland, August 9-11, 1978, ASCE, 509-517.

The numerical flow model developed by Machemehl and Gopalakrishnan for computation of flow in tidal inlets with junctions has been applied to Carolina Beach Inlet, North Carolina. The model couples the Galerkin Technique with a finite element analysis. The vertically integrated equations of momentum and mass conservation were used with appropriate boundary and initial conditions. The junction conditions were introduced by the time rates of change of energy and mass flux at the junction. A "double sweep" approach was used in solving for the dynamics of flow. An attempt was made to analyze the inlet using the linear and quadratic shape functions normally used in the finite element method. References (5 items).

Graff, J., and Karunaratne, A. "Accurate Reduction of Sea Level Records." (See complete entry in Section VII.)

Graham, D. S., Hill, J. M., and Christensen, B. A. 1978. "Verification of Estuarine Model for Apalachicola Bay, Florida," Verification of Mathematical and Physical Models in Hydraulic Engineering, Proceedings, 26th Annual Hydraulics Division

Specialty Conference, University of Maryland, College Park, Maryland, August 9-11, 1978, ASCE, 237-245.

A current research project at the Hydraulic Laboratory of the University of Florida involves linking appropriate currently available basin runoff and estuarine models to quantitatively predict the transient effects of runoff emanating from upland basin activities, particularly forestry practices, upon the biology and water quality of Apalachicola Bay, Florida. References (7 items).

Granat, M. A., and Gulbrandsen, L. F. 1982. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-82-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Tests on the Chesapeake Bay hydraulic model were conducted to specifically investigate possible changes in the hydrodynamic characteristics of velocity, salinity, and tidal elevations associated with the proposed channel enlargements. Changes in these parameters can result in changes to estuarine circulation and dynamics and sedimentation rates and patterns; can affect biological communities and distributions; and can affect dispersion of pollutants and nutrients. The present investigation included a series of base tests using the verified model with the existing Baltimore Harbor and approach navigation channels at 42 ft plus a 2-ft dredging tolerance. After these tests were completed, the channels were remolded to the new authorized 50-ft depth plus a 2-ft dredging tolerance, and a series of compatible plan tests were similarly performed for comparison purposes. Velocity and salinity were tested individually under different modes or techniques of model operation. Velocity measurements were taken at 13 selected stations while maintaining constant freshwater discharges and repetitive cosine tides. Salinity and tide height measurements were collected at 68 and 10 locations, respectively, during dynamic testing associated with time-varying boundary conditions.

Hales, L. Z. "Erosion Control of Scour During Construction; Report 8, Summary Report." (See complete entry in Section V.)

Hall, R. W., Jr. 1982. "Evaluation of Marsh Estuarine Water Quality and Ecological Models: An Interim Guide," Miscellaneous Paper EL-82-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents water quality and ecological problems in coastal marshes and estuaries, surveys applicable models for

approaches to problem solution, and pro-
vides the basis for the modeling recommen-
dations through a brief summary of water
quality and ecological modeling in the
marsh/estuarine environment. References
(102 items).

Hamilton, P. "Survey of Marine Wetland and
Estuarine Water Quality and Ecological
Problems in Corps of Engineers Field
Offices." (See complete entry in Sec-
tion V.)

Hamrick, J. M. "Baroclinic Circulation and
Dispersion in Estuaries." (See complete
entry in Section III.)

Harleman, D. R. F. 1973. "Diffusion and
Dispersion Processes," NATO Advanced Study
Institute on Estuary Dynamics, Lisbon,
Lecture No. 9.

Diffusion and dispersion processes as they
relate to mathematical modeling for water
quality control and management in estu-
aries, and the interrelationship between
mathematical models and the collection of
field data necessary for verification are
discussed. References (38 items).

Häuser, J., Eppel, D., and Tanzer, F. 1980.
"Analysis of Thermal Impact in Tidal
Rivers and Estuaries," Water Research,
14(10):1409-1419 (In English, German).

A far field mathematical model is pre-
sented for numerical simulation of tran-
sient one- or two-dimensional (2-D) ther-
mal distributions in regions with severe
reversing flow conditions. The Eulerian
formulation employs the integral form of
the conservation principles for mass and
thermal energy. The 2-D solution area is
spanned by discrete elements of variable
size and shape. The three-dimensional
geometry of the flow region is accounted
for by spatially integrating over the
enclosure surfaces of the discrete ele-
ment. The derivation of the 2-D depth-
averaged temperature equations includes
the contributions of the vertical varia-
tions of velocity and temperature. Sur-
face heat transfer and turbulent effects
are considered. Important mathematical
and computational features of the model
are summarized. There is a discussion of
the four main algorithms necessary to
treat flow regions with complex shoreline
geometries: specification of the bound-
ary, determination of all discrete element
midpoints lying within the solution area,
construction of discrete elements of ir-
regular geometry exactly matching the
boundary, and treatment of boundary con-
ditions and numerical solution of the
resulting mathematical system of weakly
coupled, ordinary differential equations
derived from the conservation princi-
ples. Preliminary results of a

computer simulation are compared with the
available data for the Lower Elbe River.
References (7 items).

Havnoe, K., Kej, A., and Siefert, W. 1983.
"Mathematical Modelling of Water Levels
and Flows in the Port of Hamburg," Dock
and Harbour Authority, 63(749):369-372.

Though located 100 km from the North Sea,
the Port of Hamburg is significantly
influenced by tides and storm surges in
the deepened Elbe River. A numerical-
hydrodynamic model has been established to
provide fast and reliable predictions of
the effects of man-made changes such as
further dredgings, introduction of new
channels, and changes in sluice operating
policies. The model is based on Sys-
tem 11, a modelling system for rivers,
channels, and similar one-dimensional
water bodies, developed by the Danish
Hydraulic Institute. References
(3 items).

Hayter, E. J., and Mehta, A. J. 1979.
"Verification of Changes in Flow Regime
Due to Dike Breakthrough Closure," Coastal
Structures 79: A Specialty Conference on
the Design Construction, Maintenance and
Performance of Port and Coastal Struc-
tures, March 14-16, 1979, Alexandria, Vir-
ginia, ASCE, II:729-746.

Methodology for the verification of
changes in the hydrodynamic regime of a
tidal waterway network due to modifica-
tions made to the network is discussed.
The methodology includes the use of two
numerical models: a discharge model which
calculates the discharge through a flow
section from a single velocity measurement
at the section, and a one-dimensional hy-
drodynamic model for a waterway network
which calculates the stage and discharge
at selected flow sections. The method-
ology is applied to the shallow waterway
network near Matanzas Inlet, Florida, to
investigate changes in the flow regime
resulting from a dike breakthrough clo-
sure. Comparison of the results obtained
from the two models is made for both
cases. Reasonable agreement is observed,
thus attesting to the validity of the
methodology. References (3 items).

Heaps, N. S. 1978. "Three-Dimensional
Modelling of the Irish Sea," Proceedings,
Sixteenth Coastal Engineering Conference,
August 27-September 3, 1978, Hamburg, Ger-
many, ASCE, III:2671-2686.

Three-dimensional modelling of the Irish
Sea has led to the determination of re-
gimes of residual elevation and current
due to wind, density, and sea-surface
gradient. These regimes are superimposed,
along with tidal residuals from two-
dimensional modelling, to yield first
estimates of mean sea level distribution

and long-term residual circulation. References (8 items).

Heaps, N. S., and Jones, J. E. 1978. "Recent Storm Surges in the Irish Sea," Marine Forecasting: Predictability and Modelling in Ocean Hydrodynamics; Proceedings, 10th International Liège Colloquium on Ocean Hydrodynamics, J. C. J. Nihoul, ed., Elsevier Oceanography Series 25, Elsevier, Amsterdam.

The tidal and meteorological conditions associated with some recent very large storm surges in the Irish Sea are described. Surges generated during a period of 10 days in November 1977 are investigated dynamically using a vertically integrated finite-difference model of the Irish Sea. Deductions are made concerning the possibilities of surge prediction for this area using a numerical model. References (8 items).

Heath, R. A. 1982. "Generation of the M_4 Tide in Cook Strait, New Zealand," Deutsche Hydrographische Zeitschrift, 35(6):261-270.

Analytical models are used to examine the generation of the M_4 tide in Cook Strait, New Zealand. The largest contribution to the M_4 tidal elevation comes from the acceleration of the constricted M_2 flow—the M_4 elevation reaches about 7 percent of the small M_2 elevation and is therefore of importance in determining the nature of the sympathetic tide in the adjacent Marlborough Sounds. The M_4 tidal flow is generally small compared to the large M_2 flow. References (10 items).

Henry, R. F. 1971. "Simulation of Tidal Motion in Complex River Systems and Inlets by a Method of Overlapping Segments," Manuscript Report Series No. 17, Marine Sciences Branch, Department of Energy, Mines, and Resources, Ottawa, Canada.

A method is presented to facilitate digital and hybrid computation of tidal motions for a coastal inlet or river system with many branches and confluences. A simple numerical experiment was implemented for testing the validity of the proposed method in a known physical situation. References (4 items).

Hickel, W. "The Influence of Elbe River Water on the Wadden Sea of Sylt (German Bight, North Sea)." (See complete entry in Section III.)

Higgs, K., Treloar, P. D., and Lawson, N. V. "Comparison of Results from Physical and Mathematical Tidal Flow Models with Prototype Data in Botany Bay." (See complete entry in Section V.)

Higuchi, H., Yasuda, H., and Hayakawa, N. 1978. "Experimental Study on Scale Effect of Tidal Model," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2646-2655.

This paper presents a comparative study of two hydraulic models of the Seto Inland Sea in order to better understand the effect of the scale effect of the hydraulic model. The larger model is built with scale ratio of 1 to 2,000 and 1 to 159 in horizontal and vertical directions, respectively. The smaller model has scale ratios of 1 to 50,000 and 1 to 500 in horizontal and vertical directions, respectively. The experimental data of this comparative study are concerned with tides, tidal current, and diffusions. References (4 items).

Holloway, P. E. "Tides on the Australian North-West Shelf." (See complete entry in Section VIII.)

Holz, K.-P., and Januszewski, U. 1980. "Automatic Calibration of Numerical Tidal Models," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2450-2460.

A method from the field of mathematical optimization was applied for the calibration of a one-dimensional river model. The model starts from the St. Venant equations which are solved numerically. The optimization leads to a closed system, so that the calibration can be performed automatically within one computer run. This leads to considerable savings in manpower and computer time. The physical transparency for the hydraulic engineer is maintained. The engineer still defines the criteria according to which the calibration is performed. The parameter set finally obtained is the best and only combination of parameters which is obtainable within a given error bound. References (4 items).

Hommel, H., and Koehler, G. 1978. "Reservoir-Model for Low-Water Regulation in Tidal Influenced Areas," Wasserwirtsch, 68(1):1-5 (In German).

A mathematical model is presented for the simulation of low-flow regulation in coastal regions by a single-purpose reservoir. Operating rules are developed regarding the special case of tide gate influence on natural runoff. Concept and application of the model are illustrated using as example a project near Wilhelmshaven. References (2 items).

Horie, T., Sato, S., and Murakami, K. 1977. "Boundary Treatment on Tidal Current Computation," Proceedings, Seventeenth Congress of the International

Association for Hydraulic Research;
Hydraulic Engineering for Improved Water
Management, 15-19 August 1977, Baden-
Baden, Federal Republic of Germany, 2:359-
366.

This paper concerns the simulation tech-
niques related with line boundary such as
breakwaters, contracted cross section such
as the open mouth of breakwaters, and ele-
vation and/or velocity control on open
boundary, in tidal current computation
based on the scheme of alternating direc-
tion implicit method developed by J. J.
Leendertse. Line boundary requires
special operation different from the case
of rigid or open boundary. Contracted
cross section is treated by the partial
modification of continuous and momentum
equations. The choice between elevation
control and velocity on open boundary de-
pends on the hydraulic properties of the
area of interest. Reference (1 item).

Hsueh, S. F., and Ahlert, R. C. 1978.
"Mixing in Shallow Coastal Sea: Case
Study," Journal, Environmental Engineering
Division, ASCE, 104(EE6):1293-1304.

Two tracer studies were used to character-
ize mixing and tidal exchange in a New
Jersey coastal sea. Several dredged chan-
nels and complex flow patterns due to is-
lands and embayments cause the system to
exchange slowly and to be mixed relatively
well internally. Tracer output at the
mouth displayed multiple peaks, a long
delay, and detectable concentrations for
several days. A transient lumped-
parameter, reactor network model was cali-
brated with the second data set. Agree-
ment between the model and field data was
good. The simulation did not perform well
with the first data set. Further, the
output was relatively insensitive to in-
put. This model is not well suited to
water quality planning and management
for the estuary studied. References
(6 items).

Hutchison, I. P. G., and Midgley, D. C.
1977. "Mathematical Modelling of Water
Level and Salinity Regimes in Some South
African Lake and Estuary Systems," Pro-
ceedings, Seventeenth Congress of the
International Association for Hydraulic
Research; Hydraulic Engineering for Im-
proved Water Management, 15-19 August
1977, Baden-Baden, Federal Republic of
Germany, 2:133-140.

Expanding agricultural and industrial
development in South Africa is disrupting
the natural water and salt balance in sev-
eral major coastal lake-bay-estuary sys-
tems. The consequent environmental impact
has in some cases been severe. The paper
is concerned with two such systems on the
Zululand coastline, viz., Lake St. Lucia

and Richards Bay. Mathematical models
simulate the behavior of the systems over
long periods of historical hydrology.
Results of calibrations against field data
are illustrated. Simulated before and
after sequences of water level and salin-
ity permit the efficacy of various engi-
neering options for improving the system
to be judged. References (4 items).

Huthnance, J. M. 1982. "On the Formation
of Sand Banks of Finite Extent," Estu-
arine, Coastal and Shelf Science,
15(3):277-299.

A model is considered where the fluid
depth depends on both horizontal coordi-
nates; quasi-steady depth-uniform nondi-
vergent fluid flow is governed by iner-
tial, pressure, and bottom-frictional
forces; sand transport is proportional to
the cube of the instantaneous current but
augmented by a down-slope component and by
wind-wave action; and sand is conserved.
It is found that low parallel banks grow
fastest, so that in an extensive spatially
uniform sea, previous calculations for
linear banks are appropriate. The incli-
nation of banks to the tidal currents can
be interpreted in terms of similarly in-
clined deposition bands resulting from
vorticity generation and advection in flow
over a small isolated hump. A small bump
can evolve to an equilibrium bank (typi-
cally after an initial rapid extension
across the tidal currents) provided that
sand is sufficiently restricted and par-
ticularly if some wind-wave action pre-
vents growth up to the sea surface. Sand
banks are likely to be in a late stage of
evolution, when the main change is a slow
lengthening as the net current and trans-
port along the bank side slow and turn
around the bank end with net deposition.
The equilibrium is apparently stable ex-
cept when there is an overall bed slope in
the direction of the tidal currents, or
when sand is abundant. References
(18 items).

Huzzey, L. M. "The Dynamics of a Bathy-
metrically Arrested Estuarine Front."
(See complete entry in Section I.)

Imasato, N. 1983. "What is Tide-Induced
Residual Current?" Journal of Physical
Oceanography, 13(7):1307-1317.

A numerical experiment was conducted to
study the velocity field of a two-
dimensional tidal current in a simple
model basin with a narrow strait. It was
found that the tide-induced transient eddy
(TITE) originated from the low pressure
area that is generated downstream behind a
headland by the nonlinearity or the cen-
trifugal force of the tidal current
flowing with a large curvature through a

narrow channel. The transient eddy is
maintained during certain phases of the
tide, and therefore the Eulerian tide-
induced residual current is the result of
the averaging process of transient phenom-
ena; the Eulerian residual current is only
a mathematical representation of the tide-
induced transient eddy and has no physical
reality. The concept of residual velocity
should be abandoned. The lifetime of TITE
depends on the magnitude of vorticity and
its dissipation. In an inner basin with
large bottom friction, the eddy diminishes
within a short time (1 or 2 hours) after
the generation, and the pressure gradient
of the eddy is smaller than the pressure
gradient of tidal flow in the strait at
the time of high-tide slack water. In
this case, TITE is swept away by the eb-
bing tidal current which flows outward
through the strait and soon disappears.
On the other hand, in a basin with small
bottom friction, because the eddy grows so
strong at the time of the start of the ebb
tide that the pressure gradient becomes
larger than that of the ebbing tide, it is
maintained by the ebbing tidal current
which runs around the eddy toward the
strait. In the latter case, vorticity
dissipation caused by horizontal eddy vis-
cosity is larger than that due to bottom
friction because of a larger horizontal
velocity shear near the eddy. References
(8 items).

Indlekofer, H. 1981. "On Numerical Stabil-
ity of One-Dimensional Sediment Transport
Models for Unsteady and Tidal Flows," Pro-
ceedings, Specialty Conference, Water
Forum '81, San Francisco, Calif., Au-
gust 10-14, 1981, ASCE, I:403-410.

The mathematical sediment transport model
used is based on the one-dimensional
St. Venant equations for water flow, the
sediment continuity equation, and a Colby
type formula for bed material transport.
The four-point implicit scheme is applied
to discretize the partial differential
equations. With the aid of the von Neu-
mann method the influence of different
physical and numerical parameters on the
numerical stability is studied. The major
results of the study are summarized in two
dimensionless graphs demonstrating the
applicability of the sediment transport
model regarding numerical stability.
References (2 items).

Isaji, T., and Spaulding, M. L. 1984. "A
Model of the Tidally Induced Residual Cir-
culation in the Gulf of Maine and Georges
Bank," Journal of Physical Oceanography,
14(6):1119-1126.

A three-dimensional nonlinear numerical
hydrodynamic model using Legendre poly-
nomials to represent the vertical struc-
ture of the horizontal currents has been
used to study the tidally induced residual

flows in the Gulf of Maine-Georges Bank
study region using a 6.25-km square grid.
Tidal elevations in terms of the M_2 phase
and amplitude along the open boundaries
are specified using Schwiderski's deep
ocean tidal model. The model predicts
strong clockwise circulation gyres around
Georges Bank and Nantucket Shoals with a
weak gyre around Browns Bank. Strong in-
flow to the Gulf of Maine is predicted
near the southwestern tip of Nova Scotia.
These results are in good agreement with
recent model predictions of Greenberg.
References (29 items).

Jain, S. C. 1982. "Movable-Bed Tidal Inlet
Model," Journal, Waterway, Port, Coastal
and Ocean Division, ASCE, 108(WW3):326-
342.

The effectiveness of movable-bed tidal
inlet hydraulic models in predicting pro-
totype behavior is evaluated by comparing
the model predictions with the observa-
tions made in the prototype. The calibra-
tion of the model, as measured by bed to-
pography changes, is evaluated by means of
quantitative indicators, including corre-
lation coefficients and root-mean-square
error. Evaluation of data from the Gal-
veston Harbor entrance model revealed that
the shoaling rates and distribution along
the navigation channel predicted by the
model are not in good agreement with the
prototype data. Disagreement between
model and prototype is believed to have
been due to scale effects introduced by
nonsimilarity of the physical processes,
insufficient prototype data for model cal-
ibration, oversimplification of the avail-
able prototype data for use in the model
study, and experimental errors. Refer-
ences (6 items).

Jenkins, S. A., Inman, D. L., and Bailard,
J. A. 1980. "Opening and Maintaining
Tidal Lagoons & Estuaries," Proceedings,
Seventeenth Coastal Engineering Confer-
ence, March 23-28, 1980, Sydney, Aus-
tralia, ASCE, II:1528-1547.

This paper reports on five separate proto-
type scale field experiments that test al-
ternative measures to dredging. Two of
these experiments evaluate techniques of
resuspension and exclusion for reducing
fine sediment accumulations in quiet
water, cul-de-sac berths, where the ob-
served shoaling rates are greatest and
dredging most difficult. These berths are
essentially sediment settling basins where
currents are insufficient to resuspend new
deposits. The fine sediment control stud-
ies were performed in and around berths at
Mare Island Naval Shipyard. Another two
experiments involved bypassing sand around
the inlet of Agua Hedionda Lagoon, Cali-
fornia, using fluidized trenches funneling
into a crater sink. The final experiment
used open trench fluidization to reopen

Penasquitos Lagoon, California. References (16 items).

Jiang, J. X., and Falconer, R. A. 1983. "On the Tidal Exchange Characteristics of Model Rectangular Harbours," Proceedings, The Institution of Civil Engineers; Part 2: Research and Theory, 75:475-489.

This paper describes a laboratory model study to determine the influence of the planform geometry, the entrance width, and the tidal range on the exchange characteristics of a simple shaped harbor, having a constant depth and planform area. The model tidal ranges, mean water depth, and planform area had scaled dimensions typical of many existing small harbors in Puget Sound, Washington, U.S.A., where in recent years concern has been expressed as to the water quality characteristics of many of these harbors. Each of the rectangular harbor configurations studied had a single asymmetric entrance and vertical sides. In the laboratory investigations the effects of wind, short period waves, and the earth's rotation have all been neglected. The laboratory results confirm that the optimum gross tidal flushing occurs for a rectangular harbor when the length to breadth ratio is between 1/2 and 2, and for lower tidal ranges ideally the harbor should be square, i.e., with a length to breadth ratio of unity. Analysis of the flow fields for the various geometries also showed that, for length to breadth ratios of less than 1/2 and greater than 2, more than one circulation cell (or gyre) was observed within the basin. Varying the entrance width confirmed that there was an optimum entrance size and the use of guide vanes positioned appropriately can lead to a marked improvement in the exchange characteristics of a poorly flushed basin. References (8 items).

Joshi, P. B., and Taylor, R. B. 1983. "Circulation Induced by Tidal Jets," Journal, Water, Port, Coastal and Ocean Engineering, ASCE, 109(4):445-464.

Steady potential motion induced by a tidal jet in an ebbing ocean is analyzed by representing the jet as a distribution of sink singularities and relating the sink strength to jet solutions for steady bottom-frictional turbulent jets over constant bathymetry. Circulation patterns are determined for various inlet configurations of practical interest and for different values of the bottom friction parameter. Particular attention is given to the jet-induced alongshore current which is shown to be sensitive to the presence of jetties and also to the bottom friction experienced by the jet. The present theory is applied to Fort Pierce Inlet, Florida, where severe erosion is known to exist on both sides of the inlet. It is suggested that the alongshore current, albeit small in magnitude, is a potential contributor to the movement of suspended beach material toward the inlet due to its continual occurrence during every ebb tide. References (24 items).

†Kabbaj, A., and LeProvost, C. "Nonlinear Tidal Waves in Channels: A Perturbation Method Adapted to the Importance of Quadratic Bottom Friction." (See complete entry in Section I.)

Kawahara, M., and Hasegawa, K. 1977. "Finite Element Analysis of Two-Layered Tidal Flow," Proceedings, Symposium on Applications of Computer Methods in Engineering, August 23-26, 1977, Los Angeles, California, L. C. Wellford, Jr., ed., University of Southern California, II:1357-1366.

In estuaries, salt water intrudes into the river so that the flow patterns of the estuaries are considerably altered. In a stratified estuary, the flow may be assumed as two-layered density flow. In this paper, two-layered tidal flow analysis has been carried out by the finite element method using the shallow water equation. The conventional finite element Galerkin method leads to a simultaneous ordinary differential equation system. To solve the differential equation, the finite element perturbation method has been applied employing a trigonometric solution. Pollutant dispersal analysis of Niigata Harbour has been analyzed by the present method. References (4 items).

Kawahara, M., and Hasegawa, K. 1978. "Periodic Galerkin Finite Element Method of Tidal Flow," Numerical Methods in Engineering, 12(1):115-127.

This paper presents the finite element method of the analysis of tidal flow. Assuming that tidal flow is periodic, the Galerkin approach is employed as the numerical integration procedure in time using a trigonometric function as the interpolation function. The present method has shown to be suitable for computation especially from the point of computing time and numerical stability. References (10 items).

Kawahara, M., Hasegawa, K., and Kawanago, Y. 1977. "Periodic Tidal Flow Analysis by Finite Element Perturbation Method," Computers and Fluids, 5(4):175-189.

The numerical analysis of periodic tidal flow is presented. The paper investigates a numerical procedure based on the mixed approach of the finite element method and the perturbation method by postulating periodic motion. Several numerical studies are presented to examine the validity of the formulation. References (18 items).

Kerssens, P. J. M., Prins, A., and Van Rijn,
L. C. 1979. "Model for Suspended Sedi-
ment Transport," Journal, Hydraulics
Division, ASCE, 105(HY5):461-476.

A mathematical model for suspended sedi-
ment transport is described, which enables
the investigation of certain effects of
river works or geometrical changes, or
both, in a river or estuary by morpholog-
ical computations. The model is based on
the two-dimensional diffusion-convection
equation. This equation describes the
distribution of the sediment concentra-
tions in a two-dimensional flow field by
diffusion and convection. For the local
velocities in the vertical the logarithmic
distribution is used, while for the sedi-
ment diffusion coefficient a new expres-
sion is applied. The diffusion-convection
equation is solved by an implicit numeri-
cal method using a coordinate transforma-
tion, while the influence of the diffusion
coefficient on the adaptation of the
transport in the case of an overcapacity
of sediment is presented. A dimensionless
graph of the adaptation length of a uni-
form concentration vertical is given, the
application of the model for tidal flow is
described, and for such conditions a pro-
totype verification and a sensitivity
analysis are given. The model is limited
to situations with relatively small
changes in lateral direction and nongraded
bed. References (14 items).

Kerssens, P. J. M., Van Rijn, L. C., and Van
Wijngaarden, N. J. 1977. "Model for Non-
Steady Suspended Sediment Transport,"
Proceedings, Seventeenth Congress of the
International Association for Hydraulic
Research; Hydraulic Engineering for Im-
proved Water Management, 15-19 August,
1977, Baden-Baden, Federal Republic of
Germany, 1:113-120.

The paper describes a mathematical model
for suspended sediment transport which
enables morphological computations to in-
vestigate the effects of human interfer-
ence and/or geometrical changes in a river
or estuary. The model is partly based on
former research on bed-load transport
models, and on the two-dimensional sedi-
ment diffusion-convection equation. This
equation describes the movement of the
sediment, in fact the distribution of the
concentrations in the two-dimensional flow
field, under the influence of diffusion,
convection, and gravity. The local veloc-
ities in the vertical are given by the
logarithmic distribution, while for the
sediment diffusion coefficient a newly
derived parabolic/constant expression is
applied. The diffusion equation is solved
by an implicit numerical method, making
use of a favorable transformation. The
method is restricted to noncohesive and
nearly uniform sediment material. A test
computation concerning the sedimentation

in a trench has been executed to verify
the applicability of the mathematical
model. References (7 items).

Knap, A. H., and Williams, P. J. LeB. 1982.
"Experimental Studies to Determine the
Fate of Petroleum Hydrocarbons from Refin-
ery Effluent on an Estuarine System,"
Environmental Science & Technology,
16(1):1-4.

This report illustrates that the important
questions relating to the processes af-
ecting the fate of organic industrially
derived pollutants in the estuarine envi-
ronment can partly be resolved by rela-
tively simple experiments. These experi-
ments also give an important insight into
what processes warrant further investiga-
tion in the ecosystem. Biodegradation
appears to be important with regard to
long-term modification of aliphatic hydro-
carbons of refinery origin. Evaporative
processes play an important role in the
short-term removal of all fractions of the
refinery effluent. However, experiments
show that the most important process which
would affect the long-term health of the
estuary is the adsorption of petroleum
hydrocarbons to estuarine sediments. This
rapid near-source sedimentation would cre-
ate a deposit of petroleum hydrocarbons
that can be released to the aqueous envi-
ronment. Subsequent analyses of surface
sediments and sediment cores from the out-
fall area indicate that approximately
25 percent of the total nonvolatile hydro-
carbon material estimated to have been
discharged from the refinery may still
reside in these sediments. References
(24 items).

Knight, D. W. "Some Field Measurements Con-
cerned with the Behaviour of Resistance
Coefficients in a Tidal Channel." (See
complete entry in Section VIII.)

Koutitas, C., and O'Connor, B. 1980.
"Modeling Three-Dimensional Wind-Induced
Flows," Journal, Hydraulics Division,
ASCE, 106(HY11):1843-1865.

A three-dimensional numerical model has
been developed to study hydrodynamic cir-
culations produced in coastal zones due to
tide and wind action. The model consists
of a mixed finite difference/finite ele-
ment solution of the simplified fluid mo-
mentum and continuity equations. A nu-
merical splitting technique is used to
reduce the size of model solution matrices
while the finite element approach is used
over the flow depth to enable irregular
seabeds to be tackled easily. Model
errors arising from the numerical method
are minimized by the use of a Galerkin
weighted-residual procedure. The problems
associated with modeling the turbulence
closure of the basic momentum equations

are also investigated with a simplified form of the model, and the need for high levels of closure is demonstrated. The potential use of the three-dimensional model is illustrated by prediction of wind-induced flows in Thessaloniki Bay in the Aegean Sea. References (21 items).

Kowalik, Z., and Matthews, J. B. "The M_2 Tide in the Beaufort and Chukchi Seas." (See complete entry in Section VIII.)

Krause, G. "Separation of Climatic Fluctuations and Impacts of Engineering Activities in Estuaries." (See complete entry in Section III.)

Kuo, C. Y., and Blair, C. H. 1978. "Comparison of Verified Physical and Mathematical Model," Verification of Mathematical and Physical Models in Hydraulic Engineering, Proceedings, 26th Annual Hydraulics Division Specialty Conference, University of Maryland, College Park, Maryland, August 9-11, 1978, ASCE, 222-229.

A physical model and a mathematical model have been used to study the Lafayette River, a small well-mixed estuary in Norfolk, Virginia. The studies include the tide heights, currents, salinity distributions and mass transport. Both types of models were verified. Results from physical and mathematical models were compared. The longitudinal salinity gradient is very small in the lower reach and the vertical profile nearly isohaline except during the period of tropical storms.

Lai, C. 1969. "A Computer Simulation Study of Traveltimes of Injected Particles and Tide-Waves in Well-Mixed Estuaries," Proceedings, Thirteenth Congress of the International Association for Hydraulic Research, 31 August-5 September 1969, Science Council of Japan, 3:123-130.

A mathematical model using the method of characteristics and appropriate numerical procedures for computer has been constructed to simulate the unsteady motion of the water-surface profile and the movements of index particles in well-mixed estuaries. Techniques in computer graphics have been applied to the model so that the numerical data of computer output representing the complex motions of water-surface movement, wave propagation, particle injection and its travel along the channel, etc., can be graphically displayed for visual observation. Two examples, cne for a hypothetical tidal reach and the other for a tidal reach in the Connecticut River, have been used to illustrate computer animation and x-y plotting by an S-C 4020 computer recorder as means of graphical outputs. Examination of the results reveals that a large

amount of qualitative and quantitative information concerning traveltimes of index particles and tide-waves can be obtained by this approach. References (8 items).

Lai, C. 1977. "Computer Simulation of Two-Dimensional Unsteady Flows in Estuaries and Embayments by the Method of Characteristics: Basic Theory and the Formulation of the Numerical Method," Water-Resources Investigations No. 77-85, US Geological Survey, Water Resources Division, Reston, Va.

Two-dimensional unsteady flows of homogeneous density in estuaries and embayments can be described by hyperbolic, quasi-linear partial differential equations involving three dependent and three independent variables. A linear combination of these equations leads to a parametric equation of characteristic form, which consists of two parts: total differentiation along the bicharacteristics and partial differentiation in space. For its numerical solution, the specified-time-interval scheme has been used. The unknown, partial space-derivative terms can be eliminated first by suitable combinations of difference equations, converted from the corresponding differential forms and written along four selected bicharacteristics and a streamline. Other unknowns are thus made solvable from the known variables on the current time plane. The computation is carried to the second-order accuracy by using trapezoidal rule of integration. Means to handle complex boundary conditions are developed for practical application. Computer programs have been written and a mathematical model has been constructed for flow simulation. The favorable computer outputs suggest further exploration and development of model worthwhile. References (16 items).

Lai, C. 1968. "The Boundary Conditions in the Implicit Solution of River Transients," Geological Survey Research 1968; Chapter C, Geological Survey Professional Paper 600-C, Geological Survey, Washington, D. C., C204-C210.

Problems in obtaining boundary conditions for the implicit method of solving tidal equations are discussed. Separate solution schemes must be established for different combinations of boundary variables. A common set is known water stages at boundaries; however, others may be easier or cheaper to obtain. An example is the condition of zero flow at a closed end or at sites where flow discharge is known or easily obtained. Several boundary-condition schemes are derived for implicit solution of the appropriate equations. Results of two examples are given. References (7 items).

Leenknecht, D. A., Earickson, J. A., and
Butler, H. L. 1984. "Numerical Simula-
tion of Oregon Inlet Control Structures'
Effects on Storm and Tide Elevations in
Pamlico Sound," Technical Report
CERC-84-2, US Army Engineer Waterways
Experiment Station, Vicksburg, Miss.

Three numerical hydrodynamic models with
progressively finer grid resolutions,
utilizing the finite difference code WIFM,
were developed for the purpose of evaluat-
ing the influence of proposed structures
under storm conditions and providing ele-
vation and velocity data for concurrent
numerical sediment transport studies at
Oregon Inlet, North Carolina. The off-
shore model encompassed the entire
Carolina coast over the continental shelf
and was used to propagate storm effects
from deep water to the finer resolution
models. The nearshore model extended from
Cape Henry to Cape Lookout, and provided
finer detail along the Outer Banks, within
Pamlico and Albemarle Sounds, and at
Oregon Inlet. This model was used for
both tide and surge simulations and was
the primary tool for establishing struc-
tural effects under storm conditions in
the Oregon Inlet vicinity. It also was
used to provide boundary conditions for
the most detailed model of the study known
as the shore process model. The shore
process model encompassed less than
85 square miles centered about Oregon
Inlet and provided high resolution at the
inlet and in the surf zone. It provided
more realistic circulation patterns of the
inlet, the effects of jetties on inlet
flow, and hydrodynamic data for concurrent
numerical sediment transport studies.
Simulations at very fine grid resolution
were made using the shore process model to
provide hydrodynamic data for numerical
sediment transport studies covering the
normal range of tides with no jetties,
four structural alternatives with a mean
tide, and the historical March 1962
northeaster with no jetties. References
(18 items).

Leitass, R. 1979. "Wave Damages to Stone
Slope Under Marginal Wharves," Coastal
Structures 79, A Specialty Conference on
the Design Construction, Maintenance and
Performance of Port and Coastal Struc-
tures, March 14-16, 1979, Alexandria,
Virginia, ASCE, II:1106-1123.

In Quebec region, site inspections showed
that a few years later after the comple-
tion of the construction of marginal
wharves on piles, the slopes under the
wharves and the pavements behind were
damaged. At the upper part of the slope,
the armor stones were displaced, and
damages to the pavement appeared in the
form of potholes and as general settle-
ments. Considering the fact that there
was no information available on what basis

the remedial works could be designed, it
was decided to run laboratory model tests
for Matane and Rivière au Renard marginal
wharves, in order to better understand the
behavior of rubble-mound slopes under the
air pressure caused by wave and tide ac-
tion. The testing in both cases was car-
ried out at Laval University's hydraulic
laboratory for different air pressure re-
lief hole arrangements and for variable
parameters, like water level, wave period,
and wave height. For each series of
tests, air pressures were recorded and the
air relief hole area in relation to the
total area was determined, which led to
practical suggestions for remedial work to
be done. References (3 items).

Lepetit, J. P., and Davesne, M. "Dynamics
of Silt in Estuary, Residual Current or
Flocculation Which Prevails?" (See com-
plete entry in Section II.)

Lepetit, J. P., and Hauguel, A. "A Numeri-
cal Model for Sediment Transport." (See
complete entry in Section II.)

Le Provost, C. 1981. "A Model for Predic-
tion of Tidal Elevations Over the English
Channel," Oceanologica Acta, 4(3):279-288.

A model for prediction of tidal elevations
in the English Channel is presented. It
is based on the classical harmonic de-
scription of tides deduced from the har-
monic development of the tide-generating
potential. The spatial distribution of
the amplitudes and the phases of the
29 harmonic constituents included in the
procedure of prediction are deduced from a
previous study: spline functions deter-
mined on the basis of these data allow to
compute these harmonic parameters at every
point of the English Channel. Two exam-
ples of application of the model are pre-
sented: first, a tidal prediction is
realized in the harbor of Le Havre over a
period of half a year and compared with
in situ observation; second, the model is
used to analyze altimetric measurements of
the sea level along subsatellite flights
across the English Channel, supplied by
the oceanographic satellite Seasat. The
predicted tides, computed by the proposed
procedure, are removed from the altimetric
measurements; this allows the demonstra-
tion that the precision of the altitude of
the satellite over the Channel, processed
during these flights, is not better than
several metres; nevertheless, these re-
sults give an estimate of the slope of the
geoid between England and France, along
the subsatellite track. References
(18 items).

Le Provost, C., and Poncet, A. "Finite
Element Method for Spectral Modelling of
Tides." (See complete entry in Sec-
tion I.)

Librach, A. S., et al. "Managing Potomac Water Quality: Evolving Approaches." (See complete entry in Section IV.)

Lie, H.-J., and El-Sabh, M. I. 1983. "Formation of Eddies and Transverse Currents in a Two-Layer Channel of Variable Bottom with Application to the Lower St. Lawrence Estuary," Journal of Physical Oceanography, 13(6):1063-1075.

Baroclinic shelf waves and Kelvin waves in a two-layer channel of variable bottom are discussed using a simple numerical model. Two different propagation directions are shown to be possible, analogous to the existence of shelf waves and trench waves in an ocean bounded by a coast with a trench, described by Mysak et al. The eigenfunctions of baroclinic shelf wave modes are quite different from the barotropic eigenfunctions; that is, each of the baroclinic modes shows a pattern similar to the first mode with the exception of small-scale structures near the coast. The model also shows the formation of a series of eddies with alternating rotat.on senses accompanied by transverse currents between two successive eddies. Eddies and transverse currents were observed in the upper layer of the lower St. Lawrence Estuary based on 4 months of direct measurements taken in 1979. The observed wavelike motion with a period of about 80 days and a wavelength of 75 km corresponded to the fourth baroclinic shelf wave modes. The observed near-surface circulation patterns with important variability in space and time are thus explained by the superposition of two baroclinic shelf waves propagating in opposite directions. References (27 items).

Liou, Y.-C., and Herbich, J. B. "Velocity Distribution and Sediment Motion Induced by Ship's Propeller in Ship Channels." (See complete entry in Section II.)

Liu, S. K., Hou, H. S., and Chang, C. C. 1978. "Simulation of Wave/Wind Forced Harbor Oscillation," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2551-2562.

This paper describes the methods used in an investigation of the response characteristics of a large man-made harbor under construction. In the investigation a three-dimensional finite difference model is applied in conjunction with physical models and field observations to assist in determining criteria for design and operation. In the modeling investigation, the dynamic response of the harbor system induced by tide, incoming short/long waves, wind stress and bottom dissipation are considered simultaneously. Particular emphasis of the study has been on the wave- and strong monsoon-induced oscillations that match the range of the resonant

period of ships and mooring systems expected to operate in the harbor. The resolution required to handle short-period oscillation and wind stress precludes the possibility of using methods involving the inversion of extremely large matrices. The results of the numerical simulation at important localities within the harbor system are later analyzed by spectral and cross-spectral methods. The same methods can then be used to study ships' responses at these localities with the predicted water level and three-dimensional current components. References (2 items).

Liu, S. K., and Leendertse, J. J. 1978. "Three-Dimensional SGC Energy Model of Eastern Bering Sea," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2687-2707.

This paper describes the development, adjustments, and verification of a three-dimensional, nonhomogeneous model of Bristol Bay and the St. George Basin. The modeled area is situated on the continental shelf area at the southeastern corner of the Bering Sea, which has one of the largest shelf areas of the world's oceans. Because of this, the water mass movement in the modeled area is driven predominantly by wind and tide, whereas waters in the deeper basin to the west are part of the cyclonic Bering Sea slope current system flowing parallel to the continental shelf break. Annual cycles of surface heating and cooling and the duration, strength, and phasing of these periods give a distinctive hydrodynamic behavior to the system. During autumn and winter, local negative buoyancy (vertically unstable) exists due to surface cooling and brine rejection during ice formation. In spring, positive buoyancy is added by freshwater runoff, ice melting, and insulation. The hydrographic structure in the modeled area is further modified by the seasonal wind, with higher mean speed in autumn and winter. References (5 items).

Lundgren, H. "Struggle of Physics and Mathematics." (See complete entry in Section I.)

McAnally, W. H., Jr. 1977. "Los Angeles Harbor and Long Beach Harbor: Physical Model of San Pedro Bay Tidal Circulation," Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, March 9-11, 1977, Long Beach, Calif., I:65-84.

A physical hydraulic model is used to assess the effects of Los Angeles Harbor and Long Beach Harbor port improvements on tidal circulation in San Pedro Bay, California. The model is of fixed-bed construction with length scales of 1:100 vertically and 1:400 horizontally. A

comparison of model results with field data obtained for model verification plus data from other sources shows that the model satisfactorily reproduces tidal circulation in the harbors. Tidal circulation in the existing harbors is dominated by a few large circulation cells that result in a net westward flow in Cerrittos Channel and a net eastward flow in the Outer Harbor. Wind effects appear to alter the gyre patterns in the Outer Harbor but are not believed to change general net flow characteristics of the harbors. It is concluded that the physical model accurately predicts important tidal circulation characteristics. References (10 items).

McAnally, W. H., Jr., Brogdon, N. J., Jr., and Stewart, J. P. 1983. "Columbia River Estuary Hybrid Model Studies; Report 4, Entrance Channel Tests," Technical Report HL-83-16, Report 4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

A hybrid modeling approach using a fixed-bed physical model, numerical models, and analytical techniques was used to study navigation channel shoaling at the mouth of the Columbia River. Sixteen plans for reducing channel maintenance dredging at the existing 48-ft depth and at 55- and 60-ft depths were tested. Effects of the plans on tides and currents were found to be subtle. Nondeepening plans had minor effects on salinity intrusion while channel deepening increased salinities by 1 to 6 ppt up to about mile 18. Only one structural plan reduced shoaling below base conditions for the 48-ft channel. Channel deepening increased shoaling considerably. References (9 items).

McAnally, W. H., Jr., and Raney, D. C. 1977. "Los Angeles Harbor and Long Beach Harbor: Physical and Numerical Tidal Models: A Comparison," Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, March 9-11, 1977, Long Beach, Calif., I:101-118.

Physical and numerical hydrodynamic models are frequently used to determine the effects of port development on tidal circulation. A comparison of field data with results from a physical model and a numerical model of San Pedro Bay, California, indicates that both are suitable for studying tidal circulation under certain conditions. The physical model has length scales of 1:100 vertically and 1:400 horizontally and models about 264 square miles. The numerical model is a two-dimensional, depth-averaged formulation solved by an implicit-explicit finite difference scheme with a rectangular grid size of 300 ft by 300 ft and a 45-sec time-step. The numerical model has 20,000 grid points and models an area of

approximately 64 square miles. Both models have been used for detailed examination of tidal circulation within the harbors of Los Angeles and Long Beach, California. The results show substantial agreement between the two models for two harbor configurations and with available field data. Net tidal flows are reproduced in direction and approximate magnitude, and large gyres occur in similar locations in both models (with some differences in strength and lateral extent). It is concluded that both models are reliable tools for studying circulation in similar well-mixed bays. References (2 items).

McAnally, W. H., Jr., et al. 1984. "Application of Columbia Hybrid Modeling System," Journal, Hydraulic Engineering, ASCE, 110(5):627-642.

The Columbia Hybrid Modeling System was applied to navigation channel shoaling problems at the mouth of the Columbia River Estuary. The models were verified to satisfactorily reproduce observed prototype behavior. The adjustment process created a typical year from a statistical analysis of river runoff and waves combined with a typical tide. References (6 items).

McAnally, W. H., Jr., et al. 1983. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth," Technical Report HL-83-16, Report 1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The Columbia Hybrid Modeling System was applied to the mouth of the Columbia River Estuary to evaluate alternatives for reducing navigation channel maintenance dredging. The hybrid modeling method uses a physical hydraulic model, analytical techniques, and various numerical models in an integrated solution method that takes advantage of the strengths of each technique while avoiding its weaknesses. The methods accounted for the effect of tides, freshwater runoff, wind waves, and littoral currents on sediment transport, deposition, and erosion. The models were verified to satisfactorily reproduce observed prototype behavior. References (50 items).

MacArthur, R. C. "Turbulent Mixing Processes in a Partially Mixed Estuary." (See complete entry in Section I.)

MacAyeal, D. R. 1984. "Numerical Simulations of the Ross Sea Tides," Journal of Geophysical Research, 89(C1):607-615.

Tidal currents below the floating Ross Ice Shelf are reconstructed by using a numerical tidal model. They are predominantly

diurnal, achieve maximum strength in regions near where the ice shelf runs aground, and are significantly enhanced by topographic Rossby wave propagation along the ice front. A comparison with observations of the vertical motion of the ice shelf surface indicates that the model reproduces the diurnal tidal characteristics within 20 percent. Similar agreement for the relatively weak semidiurnal tides was not obtained, and this calls attention to possible errors of the open boundary forcing obtained from global-ocean tidal simulations and to possible errors in mapping zones of ice shelf grounding. Air-sea contact below the ice shelf is eliminated by the thick ice cover. The dominant sub-ice-shelf circulation may thus be tidally induced. A preliminary assessment of sub-ice-shelf conditions based on the numerical tidal simulations suggests that (a) strong barotropic circulation is driven along the ice front and (b) tidal fronts may form in the sub-ice-shelf cavity where the water column is thin and where the buoyancy input is weak. References (49 items).

McClimans, T. A., and Gjerp, S. A. 1978. "Numerical Study of Distortion in a Froude Model," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2887-2904.

A numerical model utilizing a fully time-centered implicit (ADI) computational algorithm is used to investigate the effects of distortion of the laboratory model of the Tromsø Sound where advective accelerations are important. The numerical model is used to study the individual effects of bottom and side resistance in order to obtain a better understanding of the dynamics and energetics of the tidal flow. Bottom friction is modeled by Chezy's formula. Correspondingly, a lateral viscosity proportional to the local velocity is used to obtain a realistic representation of turbulent lateral momentum exchange. Deviations between the results of the models and field observations are found to be within the natural variability from one tidal cycle to the next, indicating that the laboratory simulation is not seriously affected by distortion. References (20 items).

McKay, G. R., and Tranberg, C. H. "The Development of a Dredged Estuarine Harbour--A Case Study." (See complete entry in Section V.)

Machemehl, J. L., and Gopalakrishnan, T. C. 1977. "Comparison of Numerical Simulation Flow Models for Coastal Inlets," Hydraulics in the Coastal Zone, Proceedings, 25th Annual Hydraulics Specialty Conference, Texas A&M University, College Station, Texas, August 10-12, 1977, ASCE, 1-10.

A numerical simulation model for the computation of flow in inlets with junctions has been developed by Gopalakrishnan and Machemehl. This model uses the Galerkin technique with a finite element analysis. The vertically integrated equations of momentum and mass conservation are used with the appropriate boundary and initial conditions. The finite element model is used to investigate the flow in Masonboro Inlet, North Carolina. The junction conditions are introduced by the time rates of change of energy and mass flux at the junctions. The effectiveness of the "double sweep" approach in solving the flow dynamics is described along with a discussion of appropriate shape functions. The computer results from the finite element scheme are compared with the field data and with the results from the finite difference schemes. References (3 items).

Madsen, O. S., and Grant, W. D. "Sediment Transport in the Coastal Environment." (See complete entry in Section II.)

Maiar-Reimer, E. 1977. "Residual Circulation in the North Sea Due to the M_2-Tide and Mean Annual Wind Stress," Deutsche Hydrographische Zeitschrift, 30(3):69-80.

In a high resolving (mean grid size 11 km barotropic numerical model of the North Sea tides, the M_2 tide is computed. Non-linearities of the Navier-Stokes-equation yield, in connection with an annual mean wind stress, a residual circulation fitting well to observational data. Some effects of this circulation are discussed in connection with pollution problems. References (11 items).

Mangarella, P. A., and Robilliard, G. A. "Thermal and Biological Impact of LNG Vaporizer Discharge." (See complete entry in Section V.)

Markofsky, M. 1979. "Design of a Tunnel Discharge in an Estuary-Physical Model and Field Studies," Hydraulic Engineering in Water Resources Development and Management, Proceedings, Eighteenth Congress, International Association for Hydraulic Research, Cagliari, Italia, 10-14 September 1979, 4:339-346.

A comparison between the results of physical model studies used in the design phase of a diffuser discharge in tidal waters and field measurements under operating conditions is given. The comparison helps to illustrate both the important role of laboratory model studies as a design aid for thermal discharges and some limitations of field monitoring programs for the determination of compliance with low temperature rise thermal criteria in tidal waters. References (6 items).

Maxworthy, T. 1979. "A Note on the Internal Solitary Waves Produced by Tidal Flow over a Three-Dimensional Ridge," Journal of Geophysical Research, 84(C1):338-346.

Using a simple laboratory model, the author believes to have clarified the mechanisms whereby a train of solitary waves can be generated by the barotropic tidal flow of a stratified fluid over a three-dimensional obstacle. As the tidal flow reaches critical value of the internal Froude number, a downstream depression is formed in the mixed layer. When the tide slackens and turns, this depression moves upstream and evolves into a sequence of solitary waves. Under some circumstances the depression becomes turbulent, and intense mixing takes place. In this case it is also the collapse of the mixed region that generates solitary waves which mainly propagate upstream. Available field data are consistent with this explanation, and the number of waves formed can be estimated using existing theory. References (12 items).

Maza, J. A., Munoz, M. L., and Porraz, M. "Jetties Studies Contribution." (See complete entry in Section V.)

Milford, S. N., and Church, J. A. 1977. "Simplified Circulation and Mixing Models of Moreton Bay, Queensland," Australian Journal of Marine and Freshwater Research, 28(1):23-24.

An investigation of water motions in Moreton Bay has employed existing data on tide heights and salinity to establish and check a quasi-two-dimensional mathematical model of the bay. Agreement between model and prototype tide levels is good, and the predicted circulation patterns are generally similar to the clockwise circulation inferred by earlier workers. Because of the uncontrolled numerical dispersion in the model, the predicted salinity distributions show only fair agreement with the measured values. Overall, the study identifies the following needs for further modelling: adequate treatment of multiple ocean entrances, detailed sensitivity tests, more extensive field data, and more sophisticated models. References (13 items).

Montgomery, J. R. "Predicting Level of Dissolved Reactive Phosphate in the Lafayette River, Virginia, from Information on Tide, Wind, Temperature, and Sewage Discharge." (See complete entry in Section IV.)

Morris, F. W., IV, Walton, R., and Christensen, B. A. "Point and Nonpoint Pollutant Flushing in Tidal Canal Networks." (See complete entry in Section IV.)

Muralikrishna, I. V., and Devanathan, R. 1978. "Circulation and Salinity Distribution in Coastal Inlets," Coastal Engineering, 2(2):119-131.

The mathematical model developed by Hansen and Rattray based on Pritchard's equation for a coastal-plain estuary has been analysed to study the circulation and salinity distributions in coastal inlets with constant width and depth. Numerical solutions of the basic equations have been obtained without placing any restriction on Rayleigh numbers. A noteworthy contribution of the present analysis is that solutions of equations have been obtained for higher Rayleigh numbers, which was not possible in the earlier model. It is found that the effect of higher Rayleigh numbers is to increase the vertical advection, making the salinities in the upper and lower layers more uniform, with a distinct halocline near the mid-depths. Solutions are discussed for some special cases of practical interest. References (5 items).

Murty, T. S., and Henry, R. F. "Tides in the Bay of Bengal." (See complete entry in Section VIII.)

Najarian, T. O., Wang, D-P., and Huang, P-S. 1984. "Lagrangian Transport Model for Estuaries," Journal, Waterway, Port, Coastal and Ocean Engineering, ASCE, 110(3):321-333.

A two-dimensional (in a vertical plane), nonlinear model is used to analyze tide-induced mean currents in shallow estuaries forced with tides of significant amplitude. The model is first verified by comparing its results with known analytical solutions of Lagrangian currents in a uniform and homogeneous estuary. The Lagrangian velocity fields are derived from the computed mean Eulerian and Stokes velocities in the estuary. A set of model experiments is performed to investigate the influences of tidal forcing, density gradients, and topographic variations on the mean circulation in tidal channels. It is shown that the tide-induced transport opposes density-induced transport in tidal rivers. Model sensitivity analysis indicates that for mean estuarine circulation studies, it is essential to include the coupled effects of density and tides active in the domain of interest. References (15 items).

Najarian, T. O., et al. 1984. "Application of Nitrogen-Cycle Model to Manasquan Estuary," Journal, Environmental Engineering, ASCE, 110(1):190-207.

A refined version of an ecologic and water quality mathematical model is applied to a small Atlantic coast estuarine network. The temporal and spatial variations in the

water quality of the system are examined
through the analysis of the nitrogen cycle
developed for estuarine environments. The
model is based on the mass conservation of
elemental nitrogen in its various biotic
and abiotic states. The ecologic model
structure contains two trophic levels:
primary producers and herbivorous cope-
pods. A concerted effort is made to de-
rive realistic model-governing transforma-
tions and rate parameters. The hydrody-
namic and water quality model simulations
are calibrated and verified using short-
term transient data gathered in the Manas-
quan Estuary and Point Pleasant Canal.
Model verification for abiotic constitu-
ents of the nitrogen cycle is achieved,
with biotic constituent verification need-
ing more detailed field data. Model re-
sults show the influence of transport
processes on the temporal and spatial dis-
tribution of nitrogen-cycle constituents
in the network examined. References
(16 items).

Nakagawa, H., Tsujimoto, T., and Nakano, S.
"Characteristics of Sediment Motion for
Respective Grain Sizes of Sand Mixtures."
(See complete entry in Section II.)

Nakagawa, T., and Hinwood, J. B. 1978. "A
Proposed Model of Large Scale Cellular Mo-
tion in Strong Tidal Flows," Managing the
Coast, Fourth Australian Conference on
Coastal and Ocean Engineering, Adelaide,
8-10 November 1978, The Institution of
Engineers, Australia, National Conference
Publication No. 78 11:185-189.

Large-scale cell-like eddies have been
observed in strong tidal currents. A pos-
sible mechanism for the formation of these
cells is presented, and their relation to
other turbulent flows is discussed. In
Western Port and Port Phillip, the cells
have been observed either at or just down-
stream from an area in which the seabed is
formed of sand dunes. Downstream from the
crest of each dune there will be a region
of separated flow. The proposed mechanism
views the pressure differences and flow
field in this zone of separation as the
origin of the cells. The flow over the
curved rear side of the dune gives rise to
Görtler vortices. It is proposed that the
interaction of these vortices with each
other and with the tidal currents gives
rise to the observed cells. References
(14 items).

Nece, R. E. 1984. "Planform Effects on
Tidal Flushing of Marinas." Journal,
Waterway, Port, Coastal and Ocean Engi-
neering, ASCE, 110-2:251-269.

Effects of various geometry parameters on
tidal flushing and internal circulation in
small-boat basins (marinas) of rectangular
planform were determined in physical hy-
draulic models by means of a photographic

technique incorporating the use of a pho-
todensitometer. The schematic model mari-
nas tested were scaled to have surface
areas, water depths, and tide ranges com-
parable to "prototype" marinas in the
Pacific Northwest. Results are presented
in terms of spatial average tidal flushing
(exchange) coefficients for each configu-
ration tested, and by contour drawings of
equal local per-cycle exchange coeffi-
cients for a number of configurations, all
at the same tide range. Emphasis is
placed on planform geometry and aspect
ratio, those variables over which design-
ers may have most latitude in designing a
marina for a specific site. Effects of
basin length to width ratio are delineated
for basins with typical single asymmetric
entrances. References (15 items).

Nece, R. E., and Forsyth, G. W. "Annotated
Bibliography on Tidal Flushing and Circu-
lation in Marinas." (See complete entry
in Section I.)

Nece, R. E., and Smith, H. N. 1981. "Tidal
Exchange in Proposed Sitka, Japonski
Lagoon, Small Boat Harbor," Technical
Report No. 71, Charles W. Harris Hydrau-
lics Laboratory, University of Washington,
Seattle.

The purpose of the study presented in this
report was to analyze tidal circulation
and flushing in the proposed Sitka,
Japonski Lagoon, small-boat harbor. Three
situations were investigated and d.-
scribed: (a) Existing condition. The ex-
isting shallow saltwater lagoon connects
to ambient water via a natural opening be-
tween Alice Island and Harbor Island. (b)
Constructed boat harbor. The 580-boat
harbor, with a surface area of 12 acres at
mean tide level, is to be constructed in
the saltwater lagoon. The lagoon will be
deepened by dredging, the water area will
be decreased by dredged material serving
as landfill for service areas, and the
entrance channel is to be dredged. The
basin is to be dredged to -11 feet (MLLW
datum). (c) Incorporation of brackish
lagoon. The constructed boat basin de-
scribed in (b) is to be connected via a
channel and culverts to the brackish la-
goon formed when the Sitka Airport runway
was constructed. Incorporation of the
brackish lagoon into the boat harbor cir-
culation system is considered as a restora-
tive alternative requiring wetland lost
in the dredging of the constructed harbor. The
specific objectives of the study were to
determine, by physical hydraulic model
studies, the tidal flushing rates and as-
sociated tidal circulation patterns for
each of the three situations and in part-
icular, for (c) it was desired to determine
quantitatively the tidal exchange between
the boat basin and the brackish lagoon and
within the system.

Nece, R. E., et al. 1979. "Effects of
Planform Geometry on Tidal Flushing and
Mixing in Marinas," Technical Report No.
62, Charles W. Harris Hydraulics
Laboratory, University of Washington,
Seattle.

Physical hydraulic models of small-boat
basins (marinas) possessing a rectangular
planform were tested to determine the ef-
fects of various geometry parameters on
tidal flushing and internal circulation in
small harbors. The schematic model mari-
nas were scaled to have surface areas,
water depths, and tide ranges comparable
to prototype marinas in the Pacific
Northwest. The geometry parameters inves-
tigated, to varying degrees, were
(a) planform geometry aspect ratio;
(b) ratio of entrance cross-sectional area
to basin planform area; (c) effect of
rounding of corners in the basin interior;
(d) orientation and location of single en-
trances; and, (e) effect of two entrances
versus a single entrance. Results are
presented in terms of average tidal flush-
ing (exchange) coefficients for each con-
figuration tested, and by contour drawings
of equal local per-cycle exchange coeffi-
cients for a number of configurations, all
at the same tide range, in order to com-
pare the spatial variabilities in local
exchange obtained for different planform
geometries. Emphasis is placed on those
variables--planform geometry and aspect
ratio--over which designers may have most
latitude in designing a marina for a
specific site. It is concluded that for
rectangular planform basins, optimum ex-
change, both overall and in terms of
spatial uniformity, is achieved when the
aspect ratio (basin length to width ratio)
lies between 1/2 and 2.0, the interior
corners are rounded, and the single en-
trance is centrally located in the break-
water, or enclosure, on the seaward side
of the harbor. Rounding of interior cor-
ners has little effect on average flushing
but does increase the uniformity of local
exchange throughout the basin. Effects of
basin length:width ratio are delineated
for basins with typical single asymmetric
entrances. References (22 items).

Nelson, R. C., and Keats, A. J. "A Coastal
Inlet with Fixed Bed and Mobile Sides."
(See complete entry in Section I.)

Nihoul, J. C. J., ed. Marine Forecasting;
Predictability and Modelling in Ocean
Hydrodynamics; Proceedings, 10th Interna-
tional Liège Colloquium on Ocean Hydro-
dynamics. (See complete entry in Sec-
tion I.)

Nishimura, J. K., and Lau, L. S. "Structure
for Automatic Opening of Closed Stream
Mouths." (See complete entry in Sec-
tion V.)

Nof, D. 1978. "On Geostrophic Adjustment
in Sea Straits and Wide Estuaries; Theory
and Laboratory Experiments, Part I:
One-Layer System," Journal of Physical
Oceanography, 8(4):690-702.

The dynamics of outflows from sea straits
and wide estuaries are examined through a
simplified frictionless model whose pri-
mary motions are not constrained to be
quasi-geostrophic. The potential vortic-
ity equation is solved by means of
approximate analytical methods. Some of
the model predictions are tested in the
laboratory. The mathematical model pre-
dicts that an outflow from a channel with
uniform velocity distribution deflects to
the right or left depending on the depth
of the basin into which it debouches.
There is a "critical" Rossby number below
which the flow separates from one of the
basin banks. When a nonuniform velocity
is introduced upstream, the direction of
deflection may differ substantially from
the upstream uniform flow case. The model
shows that rotation is important whenever
the ratio between the relative depth vari-
ation to the Rossby number is not negligi-
ble; rotational effects can be important
even if the ratio between the channel
width and the Rossby deformation radius is
entirely negligible. An experimental sys-
tem consisting of a rotating channel with
an abrupt cross-sectional variation was
used in the laboratory to test the theory
described above. Deflections resulting
from "supercritical" conditions were
tested qualitatively with favorable re-
sults. References (17 items).

Novak, P., and Čabelka, J. 1981. Models in
Hydraulic Engineering; Physical Principles
and Design Applications, Pitman Publishing
Inc., Boston.

Contents: 1. "Introduction," References
(2 items). 2. "Theory of Similarity,"
References (26 items). 3. "Procedure
of Investigation," References (4 items).
4. "Laboratory Installations and Instru-
mentation," References (17 items).
5. "Models of Pressure Systems," Refer-
ences (50 items). 6. "Models of Rivers
and Open Channels," References
(109 items). 7. "Models of Weirs, Dams
and Hydroelectric Power Stations,"
References (115 items). 8. "Models of
Navigation Structures and Inland Water-
ways," References (28 items). 9. "Models
of Outfalls and Public Health Engineer-
ing Plants," References (5' items).
10. "Models of Estuaries, Coastal and
Maritime Engineering Works," References
(62 items). 11. "Aerodynamic and Ana-
logue Models and Models of Groundwater
Flow," References (34 items). 12. "Field
Investigations of Hydraulic Parameters,"
References (27 items).

Nummedal, D., and Fischer, I. A. "Process-Response Models for Depositional Shorelines: The German and the Georgia Bights." (See complete entry in Section II.)

O'Connor, D. J., and Lung, W. 1981. "Suspended Solids Analysis of Estuarine Systems," *Journal, Environmental Engineering Division*, ASCE, 107(EE1):101-120.

A steady-state analysis of the distribution of suspended solids in estuaries has been developed and applied to the Sacramento-San Joaquin Delta and the James and the Rappahannock rivers. The method is based on a simplified analysis of the density-driven circulation in estuaries, resulting in a two-layered flow pattern, with the surface layer flowing seaward, the bottom layer landward, and a vertical flow between the layers for continuity. These transport coefficients, with the vertical dispersion coefficient, permit calculation of the longitudinal distribution of salinity in the two layers. The settling velocity, assigned on the basis of size and density measurements of the particles, is included in the transport equation to determine the distribution of suspended solids. Comparisons of the calculated profiles with the observed values of solids concentrations indicate good agreement and demonstrate the general validity of the approach as a practical engineering analysis. References (32 items).

O'Connor, D. J., Mueller, J. A., and Farley, K. J. "Distribution of Kepone in the *James River Estuary*." (*See complete entry* in Section IV.)

Odd, N. V. M. "Vertical Mixing in Stratified Tidal Flows." (See complete entry in Section I.)

Odd, N. V. M., and Baxter, T. 1980. "Port of Brisbane Siltation Study," *Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia*, ASCE, III:2377-2396.

The paper describes the constituent parts of a combined field and mathematical model investigation into the processes causing siltation in the Port of Brisbane. It describes the methods of collecting and using field data and laboratory results in conjunction with a variety of mathematical models which were employed to simulate and predict the interaction of tidal and fluvial flows, saline intrusion, and sediment transport in the Brisbane tidal river. A newly developed X-Z-T model was used to simulate the unsteady patterns of mud transport and siltation resulting from the interaction of tidal flows with short flashy fluvial floods, which are the main cause of shoaling in the port. The paper

discusses the structuring of the investigation which involved a carefully phased schedule of desk, field, laboratory, and mathematical model investigations with the aim of solving the problem with minimum effort and cost. The paper does not discuss predictions. References (2 items).

Odgaard, J. 1979. "Salt Exchange by Salt Fingers," *Hydraulic Engineering in Water Resources Development and Management, Proceedings, Eighteenth Congress, International Association for Hydraulic Research*, Cagliari, Italia, 10-14 September 1979, 3:319-324.

Laboratory experiments are described showing that salt fingers will form in a two-layer stratified flow under temperature and salinity conditions similar to those existing at heated discharge from power and desalination plants. The fluxes of heat and salt across the interface are measured. Some tentative calculations show that salt fingers may give rise to a significant dilution of the heated discharge. References (5 items).

O'Kane, J. P. 1978. "On the Choice of Boundary Conditions for One-Dimensional Models of Estuarine Water Quality," *Modelling the Water Quality of the Hydrological Cycle Symposium*, Proceedings of the Baden Symposium, September 1978, IAHS-AISH Publication No. 125:77-85.

The one-dimensional convective-diffusion equation is assumed to describe the dispersion of a contaminant in an estuary. Very general solutions are presented for Dirichlet (prescribed concentration) and zero Neumann (specified concentration gradient) boundary conditions. These correspond respectively to infinite and zero values of dispersion in the adjoining sea. The intermediate conditions are studied by matching at the mouth, realistic *dispersion models for both the sea and the estuary*. This provides a basis for judging the validity of the Dirichlet condition which is almost always used. References (12 items).

"Old Laboratory Tests Large Coastal Models," 1982. *Engineers Australia*, 54(24):16.

A model of Gladstone harbor covering 1,000 m² almost fills the testing hall at the recently opened Queensland Government Hydraulics Laboratory. The laboratory, on 8 ha in the Brisbane suburb of Deagon, is equipped to carry out studies of a range of coastal and estuary models. Wave basins in the testing hall have water sumps, constant head tanks, and wave and tide generators. The river model area has its own water supply and pumping facilities. The laboratory is set up specifically to prepare large-area hydraulic models of rivers and floodplains,

harbor models to study wave penetration
and siltation, coastal and estuary morpho-
logy modelling, and coastal protection
models.

Onishi, S., and Nishimura, T. "Study on
Vortex Current in Strait with Remote-
Sensing." (See complete entry in Sec-
tion VIII.)

Onishi, Y. 1981. "Sediment-Contaminant
Transport Model," Journal, Hydraulics
Division, ASCE, 107(HY9):1089-1107.

The unsteady, two-dimensional model,
FETRA, was developed to simulate both sed-
iment and contaminant transport in rivers
and estuaries. The model consists of
three submodels which, when used jointly,
accurately depict the interaction and mi-
gration of sediment, dissolved contami-
nants, and particulate contaminants.
FETRA solves the migration (transport, de-
position, and resuspension) of cohesive
and noncohesive sediments and particulate
contaminants of three sediment-size frac-
tions. FETRA was applied to the James
River estuary to simulate the migration of
river sediments and the pesticide Kepone.
Computed results produced by the model are
very similar to field-measured data, mean-
ing that FETRA is reasonably accurate.
References (20 items).

Onishi, Y., et al. "Critical Review:
Radionuclide Transport, Sediment Trans-
port, and Water Quality Mathematical
Modeling; and Radionuclide Adsorption/
Desorption Mechanisms." (See complete
entry in Section II.)

†Oonisni, Y. 1977. "A Numerical Study on
the Tidal Residual Flow," Journal of the
Oceanographical Society of Japan,
33:207-218.

A fundamental mechanism of generation of
the tidal residual flow, the steady or
quasi-steady flow induced in the tidal
current system, is studied by numerical
methods. The model basin has the same
topography as that studied by Yanagi by
means of the hydraulic model experiments.
The steady circular, horizontal current is
found to be induced through the following
processes. Horizontal friction at the
coast makes the vorticity of vertical com-
ponent in the oscillating flow. Self-
interaction of this flow causes the vor-
ticity transfer to the steady flow in
frequency domain. This vorticity transfer
is confined in the narrow coastal boundary
layer. References (5 items).

Orlob, G. T. 1973. "Simulation of Estuar-
ial Ecosystems," NATO Advanced Study In-
stitute on Estuary Dynamics, Lecture
No. 12, Laboratório Nacional de Engenharia
Civil, Lisbon, Portugal.

Simulation of estuarial ecosystems is dis-
cussed. Basic ecologic concepts such as
the estuary as an ecosystem, primary pro-
duction of the ecosystem, algae-bacteria
symbiosis, factors limiting growth rates,
growth rates at higher tropic levels, and
other environmental factors are presented
as a background. Constituents affecting
the formulation of the model are then
given. The concepts given in Lecture 11
are applied to a practical working model.
References (4 items).

Orlob, G. T. 1973. "Water Quality Modeling
of Estuaries," NATO Advanced Study Insti-
tute on Estuary Dynamics, Lecture No. 11,
Laboratório Nacional de Engenharia Civil,
Lisbon, Portugal.

Basic theoretical conditions upon which
most of the current estuarial quality
models are founded are reviewed. A brief
history of estuarial model development in
the United States from 1963 to 1973 is in-
cluded. The close relationship between
quantity and quality is considered in dem-
onstrating the need for a good hydrodynam-
ical model for quality control modeling.
References (15 items).

Outlaw, D. G. "Lake Pontchartrain and Vi-
cinity Hurricane Protection Plan; Re-
port 1, Prototype Data Acquisition and
Analysis." (See complete entry in Sec-
tion I.)

Owen, A. 1979. "Effect on the M_2 Tide of
Permeable Tidal Barrages in the Bristol
Channel," The Institute of Civil Engineers
Proceedings, Part 2, 67:907-928.

Using two-dimensional numerical models,
Owen and Heaps investigated the effects on
the tides of impermeable barrages across
the Bristol Channel at three locations in
the upper part of the estuary. It was
shown that the introduction of an imperme-
able barrage at any of the sites consid-
ered would cause a decrease in the ampli-
tude of the M_2 tidal constituent immedi-
ately seaward of the barrage. However,
for each barrage this decrease was found
to diminish on going further downstream.
The changes were greatest for barrages
located furthest seaward. In this paper
permeable barrages, each simulating a
tidal power station, are considered.
Thus, water is allowed to pass through a
barrage by means of turbines and sluices.
The flow of water and the power thereby
generated are related empirically to the
head of water across the barrage. Two-
dimensional models are used to estimate
barrage effects on the existing tides.
All the results presented concern the M_2
tide only (i.e., the principal semidiurnal
lunar tide which is responsible for the
observed 12.4-hr variation in sea level);
consequently, the spring-neap cycle is not
represented. Two possible locations are

considered for the construction of tidal power barrages. At each, the operation of a barrage with different combinations of turbines and sluices is examined. References (7 items).

Ozturk, Y. F. 1981. "Mathematical Modeling of Dispersion in Mixed Estuaries," Journal, Environmental Engineering Division, ASCE, 107(EE1):211-228.

The use of the conventional dispersion coefficient equations has met with a limited success, and they do not seem to be appropriate in tidal estuaries. An original dispersion coefficient equation has been developed for mixed estuaries. The developed equation, as a function of real-time flow depth and four-thirds power of real-time tidal velocity, represents isotropic flow conditions. In mixed estuaries the concept of isotropic dispersion may be acceptable. The dispersion model established by this equation represents adequately the rates of dispersion in the Brisbane River estuary in Australia. References (28 items).

Pape, E. H., III, and Garvine, R. W. 1982. "The Subtidal Circulation in Delaware Bay and Adjacent Shelf Waters," Journal of Geophysical Research, 87(C10):7955-7970.

Surface and seabed drifters were used to study the subtidal circulation in Delaware Bay and over the adjacent continental shelf of the Middle Atlantic Bight. Over 7,000 drifters were released in eight experiments during the yearlong study period. Velocity vector maps representing the study period mean fields for the surface and bottom confirmed the pattern of classical, two-layer, estuarine flow, with surface water moving seaward from the bay onto the shelf and bottom water landward over the shelf from at least as far as 40 km seaward of the bay mouth. Within the bay, bottom water moved laterally toward the nearest shore, diverging horizontally along a line roughly marking the deep channels. The surface speeds were about an order of magnitude larger than the bottom. Significant variations from this mean pattern were seen between the eight experiments. Return percentages for surface and bottom drifters correlated inversely over the eight experiments. Correlations with wind stress were above the level of significance, and winds explained about two-thirds of the total variance. The strong coupling found between the subtidal circulation in the estuary and over the shelf is consistent with recent observational and modelling studies. References (23 items).

Pearce, B. R., Fidler, B. R., and Humphreys, A. C. 1980. "A 3-D Model for Penobscot Bay, Maine," Proceedings, Seventeenth Coastal Engineering Conference,

March 23-28, 1980, Sydney, Australia, ASCE, III:2397-2412.

Penobscot Bay is a deep, geometrically complex, partially stratified estuary lying on Maine's Atlantic Coast. Like other Maine estuaries, the Penobscot supports economically important fisheries and tourist industries, and is a significant transportation artery. It is frequently proposed as a region suitable for new industrial and port development. Once heavily polluted by upstream paper mills, the estuary has today been substantially restored by enforcement of discharge regulations under the National Pollution Discharge Elimination System. The goal of this study was to improve knowledge of the Penobscot estuary's circulation patterns, as an important factor in maintaining the estuary's water quality and economic resource capacity. A previous effort to model Penobscot Bay (Fidler, 1978) laid the foundation for this study, but concentrated on instantaneous tidal velocities, and was hampered by a shortage of data suitable for model tuning and for comparison of modeled output. The present study concentrated on modeling residual currents, which are somewhat more interesting than instantaneous currents from the point of view of pollution control. In addition, an extensive data set, hitherto largely unanalyzed, became available for tuning and comparison. The numerical model GAL was applied to a 36- by 51-km rectangular grid covering the entire lower estuary from Fort Point to the southern end of Vinalhaven Island. Developed by Pearce, et al.(1978), it is a three-dimensional model which has a finite difference formulation in the horizontal but is continuous in the vertical. Model inputs are bathymetry, vertical eddy viscosity, wind velocity, tidal excitation at the seaward boundary, and a river inflow. Model outputs are current velocities at each grid element for specified depths, velocity profiles, and net drift information. References (5 items).

Pethick, J. S. 1980. "Velocity Surges and Asymmetry in Tidal Channels," Estuarine and Coastal Marine Science, 11(3):331-345.

Previous work on tidal dynamics in salt marsh creeks has shown that velocity and discharge exhibit well-marked surges throughout the cycle as well as a flood-ebb asymmetry. Two general models of tidal dynamics are discussed: one assuming modification of tidal stage by the marsh channel, the second assuming that channels have a purely passive role. Using the second model, a series of theoretical velocity curves are calculated using progressively more complex tidal approximations. The theory is tested using velocity data obtained from the Stiffkey

marsh, North Norfolk, England, by Bayliss-Smith et al. The velocity curve can be predicted using channel morphometric and tidal stage data. The interaction between channel morphology and the velocity curve is considered: it is suggested that channel velocity curves may provide an indication of marsh morphological development. References (11 items).

Pickett, E. B., and Greer, H. C. "Los Angeles Harbor and Long Beach Harbor: Prototype Data Acquisition and Observations." (See complete entry in Section VIII.)

Pingree, R. D., and Griffith, D. K. 1980. "A Numerical Model of the M_2 Tide in the Gulf of St. Lawrence," Oceanologica Acta, 3(2):221-225.

A two-dimensional numerical model of the M_2 tide in the Gulf of St. Lawrence and the St. Lawrence Estuary is developed in spherical polar coordinates. The model is used to predict frontal regions separating areas of tidally mixed waters from areas showing pronounced summer stratification. Marked increases in biological productivity may be associated with upwelling and mixing in these regions. References (13 items).

Pitblado, R. M., and Prince, R. G. H. "The Application of a Two-Layer Time-Dependent Model to Pollution Assessment and Control in a Short Stratified Estuary." (See complete entry in Section III.)

Praagman, N. 1982. "Comparison of Numerical Models for the Computation of Residual Currents in Coastal Seas," Deutsche Hydrographische Zeitschrift, 35(3):93-113.

In their article "The Influence of Tidal Stress," Nihoul and Ronday demonstrated the importance of tidal effects on the residual currents. Since then the method has also been recommended as an alternative to compute residual currents and has been used for practical purposes. The present study shows results which make clear that the method is less accurate than the "classical method" to obtain residual currents and also gives an explanation of these results. Moreover, the influence of the wind on the residual terms is shown to be quite large. Hence these results show that a simple superposition of residual currents as proposed by Alfrink and Vreugdenhil and van de Kreeke and Chiu is not recommendable for the model used. References (22 items).

Prandle, D. 1978. "Hydrodynamic Modelling of the Southern North Sea," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, I:1122-1141.

Numerical modelling of rivers, estuaries, and shallow seas has attracted increasing interest over the last two decades. The models have developed from one-dimensional (1D) applications to tidal propagation and flood routing through two- and, finally, three-dimensional applications to motions ranging from "pseudo-turbulence" to annual-mean residual flows. The present account describes the development, over the last 5 years, of the modelling studies carried out by the author concerning the hydrodynamics of the southern North Sea and River Thames. The objective is to identify those major points which have emerged that may have a wider significance. References (12 items).

Prandle, D. 1980. "Modelling of Tidal Barrier Schemes; An Analysis of the Open-Boundary Problem by Reference to AC Circuit Theory," Estuarine and Coastal Marine Science, 11(1):53-71.

In modelling a tidal barrier scheme, it is generally difficult to determine whether the downstream boundary is sufficiently seaward to ensure that the prescribed boundary conditions, pertaining to the existing system, remain valid after the barrier has been installed. This problem is examined using the hydrodynamic analogy with AC circuit theory; the essential elements of this theory are summarized. The first application of this theory concerns the effect of tidal barriers in the River Thames; it is shown that barriers in the region between North Woolwich and Chelsea Bridge will lead to a small increase in the M_2 tidal range. Using a number of models with the downstream boundary successively further downstream, the different results are analyzed in a manner which provides an indication of the validity of the tidal prognostication for any particular boundary location. The second application concerns the Bristol Channel where it is shown that barriers downstream of Newport will produce a small reduction in the M_2 tidal range. In view of the present interest in this region this is an important result confirming the earlier findings of Heaps. References (15 items).

Prandle, D., and Wolf, J. 1978. "The Interaction of Surge and Tide in the North Sea and River Thames," Report No. 64, Bidston Observatory, Institute of Oceanographic Sciences, Birkenhead, Merseyside, England.

An examination of surges recorded by any of the tide gages in the River Thames shows that surge peaks tend to occur 3 to 4 hr before high tide and that large peaks seldom, if ever, occur actually on high tide. These characteristics have been repeatedly confirmed by statistical analyses and are of direct relevance to such problems as flood prediction and the

determination of the probability of maxi-
mum flood levels. The effects may be at-
tributed to the interaction between tidal
propagation and surge propagation in the
area, accountable in terms of the presence
of nonlinear terms in the relevant hydro-
dynamic equations. The phenomenon of
surge-tide interaction in this context has
attracted the attention of a number of re-
searchers, but their work has not yielded
a coherent and satisfying explanation of
the mechanisms involved. The present
study seeks to clarify some of the pro-
cesses at work and includes both a statis-
tical analysis of recorded surge data and
an examination of surge-tide propagation
with the aid of numerical models. An
analysis is given of surges recorded at
various British east coast ports from
Lerwick in the northern North Sea south-
wards to Tower Pier near the head of the
Thames. Results show that surge levels
are amplified progressively as the surges
propagate southwards and that the magni-
tude of this amplification is sensibly
independent of the height of the initial
disturbance. Similarly the level of in-
teraction increases progressively from an
almost insignificant level at Wick to a
maximum at Tower Pier; an interruption in
the progression is, however, seen at
Lowestoft and reasons for this are sug-
gested. A study of discrete surge events
shows that the generation of a surge peak
on the rising tide in the Thames can occur
irrespective of the phase relationship
between tide and surge in the northern
North Sea. The present work employs a
one-dimensional numerical model of the
Thames with a seaward boundary running
approximately from Walton to Margate.
This model was used to determine the
response and sensitivity of the river to
surges of different types. The results
show that the amplification of surge
levels along the river is sensibly inde-
pendent of the surge level at the mouth
whereas the amplification is strongly
dependent on the shape (i.e. the time pro-
file) of the surge. A method of identi-
fying the mechanics of interaction in the
Thames has been developed here involving
two versions of the numerical model men-
tioned above: one of tidal propagation
and the other of surge propagation. These
two models were operated concurrently with
a cross linkage, in the form of perturba-
tion terms, by which the tide model was
influenced by the surge and the surge
model by the tide. An examination of
these perturbation terms shows the inter-
action to be proportional to a product of
surge amplitude and tidal amplitude. The
results from the models demonstrate the
relative significance of the interaction
effect of surge on tide and tide on surge,
and enable an assessment to be made of the
importance of the principal nonlinear

terms, namely quadratic friction and
(representing shallow-water influence)
products of the motion involving surface
elevation. It is shown that, in the
Thames, quadratic friction plays the domi-
nant role by severely damping surge peaks.
Also, it is concluded, both from the model
studies and from the statistical analysis
of recorded surges, that an important
component in the observed interaction in
the Thames originates outside the river.
Finally, some deductions are made concern-
ing the necessary meteorological condi-
tions under which a large surge could be
generated with a peak at, or very near,
high tide in the Thames. References
(19 items).

Prandle, D., et al. 1980. "The Use of
Array Processors for Numerical Modelling
of Tidal Estuary Dynamics," Proceedings,
Seventeenth Coastal Engineering Confer-
ence, March 23-28, 1980, Sydney, Aus-
tralia, ASCE, III:2413-2432.

The use of array processors for the numer-
ical modelling of estuarine systems is
discussed in the context of "hybrid model-
ling"; however, it is shown that array
processors may be used to advantage in
independent numerical simulations. A
hybrid model of the Bay of Fundy is de-
scribed with details of the numerical
scheme given along with various aspects
relating to the usage of the array pro-
cessor. A comparison is provided of the
performance of the array processor against
that of both a minicomputer and two main-
frame machines. References (10 items).

Price, W. A., Motyka, J. M., and Jaffrey,
L. J. "The Effect of Offshore Dredging on
Coastlines." (See complete entry in Sec-
tion V.)

Pritchard, D. W. 1973. "Hydrodynamics
Models; Section 1: Three-Dimensional
Models," NATO Advanced Study Institute on
Estuary Dynamics, Lecture No. 4, Labora-
tório Nacional de Engenharia Civil,
Lisbon, Portugal.

Basic time-dependent equations in three
spacial dimensions, expressing the conser-
vation of mass, momentum, and of a dis-
solved or finely divided suspended
constituent of the waters in an estuary
are developed. References (9 items).

Pritchard, D. W. 1973. "Hydrodynamics
Models; Section 2: Two-Dimensional
Models," NATO Advanced Study Institute on
Estuary Dynamics, Lecture No. 5, Labora-
tório Nacional de Engenharia Civil,
Lisbon, Portugal.

The basic time-dependent equations
expressing the conservation of mass,
momentum, and of a dissolved constituent
of the waters of an estuary in three

spacial dimensions developed in Lecture 4, "Three-Dimensional Models," serve as the starting point for the treatment of two-dimensional models of an estuary. Significance of terms which are neglected and simplifying assumptions which are made in order to develop a model composed of a tractable set of equations are discussed.

Proehl, J. A., and Rattray, M., Jr. 1984. "Low-Frequency Response of Wide Deep Estuaries to Non-Local Atmospheric Forcing," Journal of Physical Oceanography, 14(5):904-921.

An analytic linearized continuously stratified model which explains low-frequency response of wide deep estuaries to non-local forcing is developed. The dynamic model used for the coastal ocean is similar to that of McCreary with the effects of vertical friction and vertical and horizontal diffusion included. The response in the estuary, to lowest order, is governed by the free-wave equations. In the present study, the channel is not assumed to be narrow when compared to the local internal Rossby deformation radii. Therefore, rotation is included in the dynamics in the estuary which allows the propagation of energy upchannel as a Kelvin wave. Once obtained, the oceanic solution is matched to that in the estuary using the Green's-function matching technique of Buchwald. The results show that the response in the estuary is geostrophically controlled by the flow on the continental shelf. Additionally, the adjustment is strongest in the entrance and consists primarily of the first baroclinic mode. A simulation for real winds is run and results compared to current meter data collected in the Strait of Juan de Fuca, Washington. The comparisons show good agreement between observed and simulated response in the fjord. References (25 items).

Provis, D. G., and Lennon, G. W. 1983. "Eddy Viscosity and Tidal Cycles in a Shallow Sea," Estuarine, Coastal and Shelf Science, 16(4):351-361.

The very pronounced spring-neap tidal cycle in the South Australian gulfs leads to an unusually large variation in the magnitude of the tidal currents. Measurements of the currents in these gulfs show that the nontidal circulation depends on the strength of the tidal currents and hence on the spring-neap cycle. A simple model is produced in which the vertical eddy viscosity is a function of both wind strength and tidal currents. Results from the model agree with the observations and suggest a means whereby variations in tidal mixing may be accounted for in hydrodynamic modelling of the circulation in shallow seas. References (11 items).

Pruszak, Z., and Zeidler, R. B. "Sediment Transport and Ripples Due to Waves and Currents." (See complete entry in Section II.)

Ramming, H.-G. "The Influence of River Normalization on the Distribution of Tidal Currents in the River Elbe." (See complete entry in Section I.)

Raney, D. C. 1977. "Los Angeles Harbor and Long Beach Harbor: A Numerical Model for Tidal Circulation," Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Long Beach, Calif., March 9-11, 1977, I:85-100.

Los Angeles Harbor and Long Beach Harbor have expansion plans under study involving extensive modifications of port facilities to accommodate increased tanker and general cargo traffic. The proposed modifications involve dredging of deeper channels and the creation of additional berthing facilities adjacent to new fill areas. To assist in determining the environmental impact of proposed harbor modifications, physical and numerical modeling programs are being conducted at the US Army Corps of Engineers Waterways Experiment Station (WES). A large physical model of San Pedro Bay exists at WES. To supplement and complement the physical modeling effort, a numerical model was developed to investigate tidal circulation. This paper deals with the numerical modeling of tidal circulation patterns in Los Angeles Harbor and Long Beach Harbor; its calibration for existing conditions; and its use as a predictive tool for potential modification to the existing harbor complex. References (7 items).

Richards, D. R., and Gulbrandsen, L. F. 1982. "Low Freshwater Inflow Study; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-82-3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Future population increases in the Chesapeake Bay area will increase the demand for fresh water from its tributaries. A portion of this demand will be in the form of consumptive losses. In order to predict the impact of these consumptive losses on the Chesapeake Bay and future water resource programs, a study was initiated in a physical model of Chesapeake Bay to compare tide, velocity, and salinity data for a historical period of low flow with data resulting from freshwater inflow suppressed by the consumptive losses that may be expected some 50-60 years in the future. A base test simulating drought water years 1963-1966 was designed to reproduce known low-flow conditions, and a future test was designed to portray water years 1963-1966 combined with anticipated consumptive losses and diversions for 50

to 60 years in the future. Both tests contained a number of consecutively run, average year hydrographs to assess the bay's rebound potential following a drought period. Sampling for each test resulted in a data set that includes 7 years of continuous hourly tide records at 22 stations distributed throughout the bay, hourly current velocities over complete (13 hr) tidal cycles taken at 16 stations 8 times, and approximately 250,000 salinity values during each test. There were 206 salinity sampling stations each having from 1 to 5 sampling depths. Analysis of the data could not address the entire data set; therefore, 32 stations were selected as being representative of the bay and generalizations were made on these stations to assess the effectiveness of the study. Results of the analysis show a general increase in salinity values in the future condition throughout the bay on the order of 1 to 3 ppt. The differences were greater or less locally depending on the station location. Little differences in tides and current velocities were noticed between tests. Variations in vertical salinity structures between spring and neap tide were seen at some stations in the bay, although there was generally little change resulting from the consumptive losses. The bay's rebound after drought conditions was assessed at several stations and the data indicated a return to a state of dynamic normalcy within 3 to 6 months at all stations analyzed for both tests.

Richards, D. R., and Morton, M. R. 1983. "Norfolk Harbor and Channels Deepening Study; Report 1, Physical Model Results; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-83-13, Report 1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents the findings of physical model tests of deepening the approach channels to Norfolk and Newport News, Virginia. The tests included a steady-state portion for the determination of the tide and current velocity effects of channel deepening as well as a dynamic portion where variable tide and freshwater inputs were used to study salinity redistributions. Results of the tests indicate salinity changes to the estuary which can be attributed to channel deepening. On the average, the changes are small, normally less than 2 ppt, in an extremely dynamic portion of the estuary where natural salinity fluctuations due to variations in tides and freshwater input can cause weekly variations an order of magnitude greater. References (9 items).

Rives, S. R., and Pritchard, D. W. 1978. "Adaptation of J. R. Hunter's One-Dimensional Model to the Chesapeake and

Delaware Canal System," Special Report 66, Reference 78-6, Chesapeake Bay Institute, Johns Hopkins University, Baltimore, Md.

A one-dimensional mathematical model has been adapted to the Chesapeake and Delaware Canal. This study extends the modeling work of Gardner and Pritchard by including the portion of the canal system between Town Point Neck and Chesapeake City and the portion between St. Georges and Reedy Point. The model is driven by time series of observed water surface elevations at Town Point and Reedy Point. Model calibration was accomplished using current velocity measurements, and tracer dye data taken at interior points. Current meter measurements were made in April/May 1975 at two locations in the dredged section of the canal. Mean flows over single tidal cycles are plotted and listed for comparison with the results from 1973 data. The tidally averaged transport values computed from the current meter records for the two sections are in agreement within the accuracy of the observations. References (7 items).

Robinson, I. S. 1983. "A Tidal Flushing Model of the Fleet--An English Tidal Lagoon," _Estuarine, Coastal and Shelf Science_, 16(6):669-688.

Observations of the spatial distribution of salinity and tidal salinity fluctuations along the length of the Fleet are presented, and different structures are identified with different freshwater runoff conditions. The salinity distribution appears to be the result of a balance between weak tidal flushing and a small freshwater input. A tidal exchange box model is developed to represent this weak balance and is able to reproduce the semidiurnal, fortnightly, and seasonal fluctuations of salinity. By use of the tuned model, estimates are made of the flushing times of different segments of the lagoon, the distribution of water from particular stream inputs, and hence their polluting potential, and the likely effect on the salinity structure of changes in the tidal regime which could result from sediment deposition. References (5 items).

Robinson, I. S., Warren, L., and Longbottom, J. F. 1983. "Sea-Level Fluctuation in the Fleet, an English Tidal Lagoon," _Estuarine, Coastal and Shelf Science_, 16(6):651-668.

Tidal elevation data are presented for places along the length of the Fleet, which is a tidal lagoon behind Chesil Beach on the south coast of England. Harmonic analysis of the data is not able to represent the observations adequately, particularly at the inner end of the lagoon. However, careful inspection of the

data shows that the tidal regime is capa-
ble of being understood in terms of the
nonlinear propagation of long waves
in very shallow water. Distortion of the
tidal wave by unequal progression speeds
of high and low water and the setup of
mean level by frictional effects are shown
to be the important physical mechanisms
controlling the observed water level fluc-
tuations. A one-dimensional numerical
model which incorporates these processes
is able to reproduce the observations
satisfactorily. While the model predicts
strong effects of wind stress, the meteo-
rological influences in the observed data
appear to be largely due to external
surges in the English Channel which propa-
gate into the lagoon through its entrance.
References (8 items).

Rodenhuis, G. S., Kjaer, O. B., and Bertel-
sen, J. A. 1977. "A North Sea Model That
Can Provide Detailed Hydrographic Informa-
tion," Proceedings, Ninth Annual Offshore
Technology Conference, May 2-5, 1977,
Houston, Tex., 2:325-330.

Severe storm conditions and normal tidal
conditions in the North Sea have been
used to verify a fast-running computer
model based on the complete nonlinear
equations for nearly horizontal flow, in-
cluding wind stresses, barometric pressure
gradients, Coriolis forces, and bottom
shear stresses. The model can focus on
freely selected areas where the mesh size
is reduced to one-ninth of that of the
coarsest grid. The detail of the local
area is computed simultaneously in the
fine grid from the general conditions in
the coarse grid. When complemented with a
short, intensive program of local measure-
ments, the model can provide detailed in-
formation on currents and surface eleva-
tions. This allows forecasts of extreme
conditions and statistics of occurrences
and magnitudes on the basis of meteorolog-
ical information. References (4 items).

Rodger, J. G. "Simulation of Stratified
Flows in Estuaries." (See complete entry
in Section II.)

Scheffner, N. W., et al. 1981. "Verifica-
tion of the Chesapeake Bay Model; Chesa-
peake Bay Hydraulic Model Investigation,"
Technical Report HL-81-14, US Army Engi-
neer Waterways Experiment Station, Vicks-
burg, Miss.

The Chesapeake Bay model, a fixed-bed
model constructed to a horizontal scale
ratio of 1:1,000 and a vertical scale
ratio of 1:100, reproduced the Chesapeake
Bay from the ocean to the head of tides
for each tributary. Reproduction extended
to the +20 ft contour. The model was
equipped with the necessary appurtenances
to accurately reproduce and measure tidal

heights, tidal currents, salinity distri-
butions, and freshwater inflows. Due to
the immense size of the model (8.6-acre
model housed in a 14-acre building), com-
plete computer control and data acquisi-
tion capabilities were provided. Severe
limitations in prototype data in addition
to substantial wind contamination of those
data necessitated a detailed data analysis
program which resulted in a modified ap- •
proach to physical model verification.
This was accomplished in the following two
separate modes of operation: (a) verifi-
cation for tidal heights and tidal veloci-
ties using an M_2 constituent tide and a
constant long-term freshwater inflow and
(b) verification for salinities using a
typical 28-day tidal cycle (with long-
period wind energy filtered out) and in-
flow hydrographs reproduced in 2-week
time-steps. A bubbler system was incor-
porated in the model to statistically
reproduce the vertical mixing caused by
wind fields acting on the prototype.
Excellent verification of the model was
achieved. References (8 items).

Schwarze, H., and Falldorf, W. 1978. "In-
fluence on Temperature Increases in Tidal
Rivers Caused by Waste Heat Injections
with Respect to Tidal Cycles and Storm
Surges," Proceedings, Sixteenth Coastal
Engineering Conference, August 27-Sept-
ember 3, 1978, Hamburg, Germany, ASCE,
III:2915-2924.

The influence of tidal cycles with neap
and spring tides or of storm surge events
on the distribution of temperature in-
creases caused by heat injection in an
estuary was investigated in a thermal-
hydraulic model. The results of the model
tests have shown that under natural tidal
conditions as of the Elbe River during
tidal cycles as well as storm surge events
in the far field region, no higher temper-
ature increases occurred than under mean
tidal conditions.

Seabergh, W. C. 1979. "Model Testing of
Structures at a Tidal Inlet," Coastal
Structures 79, A Specialty Conference on
the Design Construction, Maintenance and
Performance of Port and Coastal Struc-
tures, March 14-16, 1979, Alexandria, Vir-
ginia, ASCE, II:690-709.

During the course of a model study of
Masonboro Inlet which was part of the
Corps of Engineers General Investigation
of Tidal Inlets research program, a vari-
ety of structural changes to the inlet re-
gion were examined. One series of tests
concerned the closure of bay channels.
The bay system of Masonboro Inlet is com-
posed of three distinct channels which di-
verge from the inlet's gorge. The tests
were designed to investigate the effect of
closing one of the three channels or the

tidal hydraulics for each of the three possible cases. Possible effects on the inlet's morphology were then extrapolated from the model results and for one case were compared to an actual closure condition in the prototype. References (12 items).

Seabergh, W. C., and Lane, E. F. 1977. "Improvements for Little River Inlet, South Carolina; Hydraulic Model Investigation," Technical Report H-77-21, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The Little River Inlet fixed-bed model, constructed of concrete to scales of 1:300 horizontally and 1:60 vertically, reproduced an area extending to the -40 ft contour in the Atlantic Ocean and to the extent of the influence of the tidal prism on the AIWW. Areas throughout the lagoon were accurately reproduced, and model verification tests of tidal elevations, velocities, and salinities assured that the model hydraulic regimes were in satisfactory agreement with the prototype. Model testing concluded that Plan 2D-1 which included weir sections backed by deposition basins for both jetties would be the most feasible plan. The mean tide level weirs would permit sand transport to the basins on flood tide but would prevent ebb flows from existing over them due to the tidal elevation-velocity relations characteristic of Little River Inlet where maximum ebb velocities occur after the tide elevation has fallen below midtide. Also, flow in the entrance channel was ebb-dominant which would aid in flushing sediment out of the channel. The sand-trapping abilities of the deposition basins permitted shortening of the jetties since a large amount of sand fillet storage would not be needed and sand movement around the jetty tips would be minimized. Testing also indicated there would be no significant change to the bay tidal prism or salinities. References (12 items).

Seabergh, W. C., and Outlaw, D. G. 1984. "Los Angeles and Long Beach Harbors Model Study; Numerical Analysis of Tidal Circulation for the 2020 Master Plan," Miscellaneous Paper CERC-84-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

A study to determine the effect of the proposed 2020 Master Plan on tidal circulation in Los Angeles and Long Beach Harbors was conducted using a numerical model with a two-dimensional depth-averaged formulation of the hydrodynamic equations. The model, which had been verified in a previous study, used an implicit finite-difference scheme to numerically solve the equations. To observe the dispersion of conservative substances, the model also incorporated the two-dimensional

conservative constituent transport equations. The 2020 Master Plan consists of placing 2,600 acres of landfill at various locations throughout the harbors. Tidal circulation was studied for 70-hr sequences of spring, mean, and neap tides for each of three harbor configurations: (a) existing configuration (1983), (b) landfills placed on existing bathymetry, and (c) landfills placed with increased channel depths. The 2020 Master Plan produced no changes in tidal elevation or phase throughout the harbors. The tidal prism was reduced by the amount of displacement of the landfill. Flow distribution entering and exiting the harbor through Angel's Gate, Queen's Gate, and the east end were not significantly affected. The net flow in the inner harbor (Main Channel and Cerritos Channel) was reversed from the existing westerly flow to an easterly flow; however, the net flow volumes for both existing and planned conditions were small relative to the total flow volumes. Channel deepening combined with the 2020 Master Plan reduced large horizontal eddies in the outer harbor, permitting more efficient flow into the inner harbor area from Angel's Gate to the Main Channel. Dye tests indicated good flushing and mixing in the outer harbor. References (10 items).

Seabergh, W. C., and Sager, R. A. 1980. "Supplementary Tests of Masonboro Inlet Fixed-Bed Model; Hydraulic Model Investigation," GITI Report 18, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The report describes supplemental tests of the Masonboro Inlet fixed-bed model not reported in "Physical Model Simulation of the Hydraulics of Masonboro Inlet, North Carolina," GITI Report 15. The supplemental tests consist of three separate studies performed in the Masonboro Inlet fixed-bed model. The first study examines the effects of the closing of various bay channels on the inlet's hydraulics. The second study examines the effects of the addition of a south jetty to the existing condition which has a single north jetty and examines the resulting hydraulics for various weir elevations on both jetties. The third study examines the use of a tracer material and closely parallels the hydraulic testing sequence discussed in the previous Masonboro Inlet report. The tracer tests include verification of the 1969-1971 shoaling trends, testing of the prejetty 1964 condition, testing of the single jetty plan with the 1964 bathymetry, and testing of the postjetty construction 1966 condition. These tests were performed to evaluate the effectiveness of using sediment tracer materials in inlet model studies. Results indicate the closure of any of the three interior channels in Masonboro Inlet produces a

signiicant change in the inlet hydraulics and would most likely produce a significant change in morphology as illustrated by the prototype case history. References (18 items).

Seelig, W. M., and Sorensen, R. M. 1978. Numerical Model Investigation of Selected Tidal Inlet-Bay System Characteristics," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1302-1319.

A spatially integrated one-dimensional numerical model of inlet-bay hydraulics has been combined with a simple sediment transport model to investigate selected tidal inlet-bay system characteristics. A parametric study has been performed using the models to determine the effect of various factors on the net direction and order of magnitude of inlet channel flow and sediment transport. Factors considered include astronomical tide type, storm surge height and duration, variation in bay surface area, time-dependent channel friction factor, and the addition of a second inlet connecting the bay and sea. References (7 items).

Sengupta, S., Lee, S., and Bland, R. A. 1976. "Three-Dimensional Model Development for Thermal Pollution Studies," Proceedings, Conference on Environmental Modeling and Simulation, April 19-22, 1976, Cincinnati, Ohio, EPA 600/9-76-016:522-526.

A three-dimensional thermal pollution mathematical model is developed; this can include effects of winds, ocean currents, cyclic tidal flushing in bays and estuaries, variable winds, and realistic bottom topography. References (14 items).

Sengupta, S., Lee, S. S., and Miller, H. P. 1978. "Three-Dimensional Numerical Investigations of Tide and Wind-Induced Transport Processes in Biscayne Bay," Sea Grant Technical Bulletin No. 39, University of Miami, Coral Gables, Fla.

An outline is given of the tide and wind-driven circulation in Biscayne Bay, South Florida, a shallow-water estuary. Present studies include calibrating two three-dimensional numerical free surface models which can then be used to predict the distribution of sediment transport within the bay. Further investigations will be carried out into salinity effects using proven finite element techniques. References (39 items).

Sharp, J. J. 1981. Hydraulic Modelling, Butterworth, Boston.

This book provides a comprehensive guide to the theory and practice of hydraulic models and their design, construction, and operation. Hydraulic phenomena are too complex to be described by mathematical techniques. Scale models play a decisive part in the evaluation of many hydraulic schemes. Part 1, "General Theory," includes the necessary study of similarity theory and scale errors. Part 2, "Practice," describes the modelling of river, tidal, thermal, and effluent schemes. Included are sections on hydroelectric schemes and snow and ice models. References are given at the end of each chapter with a selected bibliography for Part 1.

Sheng, Y. P. 1983. "Mathematical Modeling of Three-Dimensional Coastal Currents and Sediment Dispersion: Model Development and Application," Technical Report CERC-83-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

A comprehensive model of coastal currents and sediment dispersion has been formulated and applied to the Mississippi Sound and adjacent continental shelf waters. The study combines mathematical modeling of various hydrodynamic and sedimentary processes with laboratory and field experiments. Of primary importance is the development of an efficient and comprehensive three-dimensional, finite-difference model of Coastal, Estuarine, and Lake Currents (CELC3D). The model resolves currents driven by tide, wind, and density gradient. It has been applied to the Mississippi Sound, and results agree well with measured surface displacements and currents during two episodes. Rates of entrainment and deposition of the Mississippi Sound sediments have been studied in a laboratory flume. Effects of (a) bottom shear stress, (b) bed properties, (c) salinity of water, and (d) sediment type on the erodibility of sediments have been examined. Results of the laboratory study have been incorporated into the bottom boundary conditions for a three-dimensional sediment dispersion model. Gravitational settling and particle size distribution of the Mississippi Sound sediments were also studied in laboratories. Bottom boundary layer dynamics and wave effect on sediment dispersion have been studied by means of a turbulent transport model and a wave model. Model simulations of sediment dispersion in the Mississippi Sound agree well with available data from ship surveys. References (120 items).

Sheng, Y. P. 1984. "Preliminary User's Manual, 3-D Mathematical Model of Coastal, Estuarine, and Lake Currents (CELC3D)," Instruction Report D-84-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

An efficient and comprehensive three-dimensional finite-difference model of Coastal, Estuarine, and Lake Currents (CELC3D) has been developed and is

currently operative on a VAX-11/780 mini-computer. This user's manual discusses the special model features, general structure of the CELC3D computer code, sub-program summary, input/output information, data requirements, and example calculation.

Signorini, S. R. 1979. "A Three-Dimensional, Finite Element Numerical Model of Circulation and Diffusion-Advection Processes for Estuarine and Coastal Application (With Application to Bay of Ilha Grande, Brazil)," Ph. D. Dissertation, University of Rhode Island, Kingston.

This study consists of the development of a three-dimensional numerical model suitable for applications to tidal, wind-driven, and density-driven flows in estuaries and coastal regions. Both velocity and density fields are solved for by using a coupled system of momentum, continuity, and conservation of density equations. This is to say, the density stratification plays a dynamic role in the solution scheme by means of a mutual adjustment of the velocity and density fields through the conservation of density equation. The solution strategy of the model developed in this study is an extension of the one employed in the barotropic model of Wang and White (1976). The model is capable of assuming Coriolis force effects and continuous density stratification and of including nonlinear effects by the use of the complete conservation of momentum and density equations and variable bottom topography. The transfer of mass and momentum between layers is achieved by the use of constant eddy viscosity and eddy diffusivity coefficients. The bottom friction and the wind stress are introduced by means of empirical relations similar to Wang's model. A coordinate transformation is used to transform the normal vertical coordinate into a stretched vertical coordinate in order to keep the domain boundaries constant at all layers. After using the finite element integration in space coordinates, the original system of partial differential equations becomes a system of ordinary differential equations with respect to time. The continuity, momentum, and density conservation equations are then integrated with respect to time in successive time steps. To model the tidal portion of the flow, the scheme uses a boundary condition at the ocean boundaries of the domain by imposing a cooscillating tidal signal to drive the free-surface elevation. Preliminary test runs were conducted to investigate the accuracy and general behavior of the three-dimensional model. The model was tested for river outflow and density stratification conditions which simulate the exact similarity solutions of Hansen and Rattray (1965) for an idealized recti-linear estuary. Very good agreement was obtained between the model profiles and the similarity theory, with the model velocity profiles being more physically realistic at the bottom. An experiment involving the spin-up of an oblong-shaped lake by a linear wind stress distribution for an initially linearly stratified lake is also presented. The results showed to be consistent with the dynamics involved in the problem but no analytical comparison was available for this experiment. As its principal practical experiment, the model was applied to the estuarine system formed by Bay of Ilha Grande and Bay of Sepetiba (Rio de Janeiro, Brazil). A preliminary assessment to the tidal and wind-driven portions of the circulation was successfully accomplished by using a two-dimensional finite element model developed by Wang (1975). A limited amount of field data necessary to test the model's ability to reproduce and predict the circulation patterns observed in the region was provided by field work undertaken in September 1977 together with the data already available for the region. Next, the three-dimensional model was applied to the Bay of Ilha Grande region including bottom topography, density stratification, and tidal forcing. The initial density stratification was provided by a simple linear function of the three coordinates, with slopes calculated from the density gradients provided by the hydrographic field work. The model results proved to be in reasonable agreement with the available field data, and the accuracy obtained seems to be closely related to the ability of the grid system adopted to reproduce the real geometry and to the quality of the real initial and boundary conditions available to drive the model. References (45 items).

Simpson, J. E., and Britter, R. E. "Experiments on the Dynamics of the Front of a Gravity Current." (See complete entry in Section I.)

Smith, N. P., and Kierspe, G. H. 1981. "Local Energy Exchanges in a Shallow, Coastal Lagoon: Winter Conditions," Estuarine, Coastal and Shelf Science, 13(2):159-167.

A 110-day time series of estuarine water temperature is used to verify a numerical model of local air-water heat exchanges under winter conditions in a shallow, bar-built estuary on South Florida's Atlantic coast. Quasi-periodic frontal passages during the winter of 1977-78 produced cycles of heating and cooling over time scales of about a week. Temperatures decrease 4°-7° C during the first few days following frontal passages. Model results suggest that the daily net water temperature change is most strongly correlated

with, and is therefore primarily in re-
sponse to, sensible and latent heat
fluxes. Heating by insolation and cooling
by long-wave radiation are substantial,
but in both cases the correlation with the
net daily temperature change is not sta-
tistically significant. Conductive ex-
changes with the underlying sediments
appear to play a minor role in the estu-
arine heat budget. The root-mean-squared
error of simulated water temperatures
asymptotically approaches a value of
approximately 1.0° C for time intervals
of between 2 and 30 days. References
(9 items).

Smith, T. J. 1982. "On the Representation
of Reynolds Stress in Estuaries and Shal-
low Coastal Seas," Journal of Physical
Oceanography, 12(8):914-921.

A model for the representation of the
Reynolds-stress tensor in three-
dimensional hydrodynamic models of
shallow-water flows is derived which
combines the accuracy of turbulence energy
closure schemes with the computational
efficiency of algebraic eddy viscosity
models. The proposed model assumes the
eddy viscosity tensor to have structural
similarity, from which it is shown that
its magnitude is scaled on the depth-mean
turbulence energy and the depth-mean tur-
bulence energy dissipation rate, while the
vertical structure is described by a
suitable similarity function, two alter-
natives of which are derived. The simi-
larity assumptions used in the analysis
are verified and the model is tested by
application to steady and tidal flows.
References (19 items).

Smith, T. J., and O'Connor, B. A. 1977. "A
Two-Dimensional Model for Suspended Sedi-
ment Transport," Proceedings, Seventeenth
Congress of the International Association
for Hydraulic Research; Hydraulic Engi-
neering for Improved Water Management,
15-19 August 1977, Baden-Baden, Federal
Republic of Germany, 1:79-86.

The paper describes a two-dimensional
mathematical model which enables the lon-
gitudinal and vertical distributions of
velocity and suspended solids to be deter-
mined in estuarial-type flows. The model
operates on a real-time basis and consists
of an ADI-type finite difference solution
of the basic laterally integrated momentum
and continuity equations for fluid and
sediment. The difficulties of modelling
natural-shaped sediment channels by the
laterally integrated approach is high-
lighted and suggestions given to enable
the two-dimensional approach to be used in
practice. A simplified form of the model
is applied to a simple steady flow labora-
tory situation and shown to give good re-
sults as regards the fluid velocities but
not as good results regarding the sediment

field. The discrepancies are attributed
to inaccurate laboratory results. Deposi-
tion rates can be predicted provided an
appropriate reentrainment coefficient is
used. References (9 items).

Sorensen, R. M. "The Corps of Engineers
General Investigation of Tidal Inlets."
(See complete entry in Section I.)

Spaulding, M. L. 1984. "A Vertically Aver-
aged Circulation Model Using Boundary-
Fitted Coordinates," Journal of Physical
Oceanography, 14(5):973-982.

A two-dimensional vertically averaged cir-
culation model using boundary-fitted coor-
dinates has been developed for predicting
sea level and currents in estuarine and
shelf waters. The basic idea of the ap-
proach is to use a set of coupled quasi-
linear elliptic transformation equations
to map the physical domain to a corre-
sponding transformed plane such that all
boundaries are coincident with coordinate
lines and the transformed mesh is rec-
tangular. The hydrodynamic equations are
then solved by a multioperation finite
difference technique in the rectangular
mesh transformed grid. Comparisons of the
circulation model predictions for tidally
forced flows in a wedge section with both
flat and quadratic bottom topography, and
in a flat channel with exponential varia-
tion in width, were in excellent agreement
with corresponding analytic solutions.
Simulation of steady-state wind-induced
setup in a closed basin formed using el-
liptic cylindrical coordinates also was in
excellent agreement with the analytic so-
lution. Finally, the model was applied to
predict the M_2 tidal circulation in the
North Sea and accurately reproduced the
well-known amphidromic systems present in
this region. References (37 items).

Stark, K. P. 1978. "Simulation and Proba-
bilities of Tide and Cyclonic Storm
Surges," Managing the Coast, Fourth Aus-
tralian Conference on Coastal and Ocean
Engineering, Adelaide, 8-10 November 1978,
The Institution of Engineers, Australia,
National Conference Publication No.
78/11:44-48.

A simulation model is presented for the
determination of probabilities of water
levels attained by the combination of
astronomical tide and storm surge at a
nominated location. The model uses a
previously developed numerical hydrody-
namic storm surge model SURGE which ac-
counts for the shape of the coastline, the
bathymetry of the area, and the cyclone
characteristics. SATURN uses long-term
Monte Carlo simulations to generate
cyclones of the appropriate character-
istics in a Poisson process and super-
imposes the associated astronomical tide
on the accompanying storm surge. The

probabilities and return periods of com-
bined water levels produced should prove
useful to coastal engineers, developers,
civil defense, mitigation, and insurance
organizations. References (11 items).

Stephens, H. S., and Stapleton, C. A., ed.
Papers Presented at the Second Interna-
tional Symposium on Wave and Tidal Energy,
September 23-25, 1981, Cambridge, England.
(See complete entry in Section I.)

Stevens, H. H., et al. 1973. "Model for
Sediment Transport Through an Estuary
Cross Section," Hydraulic Engineering and
the Environment, Proceedings, 21st Annual
Hydraulics Division Specialty Conference,
Montana State University, Bozeman, Mon-
tana, August 15-17, 1973, ASCE,
279-291.

The paper describes a semiempirical mathe-
matical model used to define one-
dimensional temporal variation of sus-
pended sediment concentration in the
Columbia River near Astoria. The method
of characteristics was used for solution
of the model, and some values had to be
adjusted to actual flow measurements.
Maximum turbidity develops in different
parts of the estuary and translates
longitudinally, depending on flow con-
ditions. Agreement between computed and
observed concentrations was satis-
factory. References (12 items).

Stigebrandt, A. "A Mechanism that Regulates
the Mean Longitudinal Density Gradient in
the Brackish Layer in Fjords with Topo-
graphical Control at Their Mouths." (See
complete entry in Section I.)

Stroband, H. J., and Wijngaarden, N. J. V.
1977. "Modelling of the Oosterschelde
Estuary by a Hydraulic Model and a Mathe-
matical Model," Proceedings, Seventeenth
Congress of the International Association
for Hydraulic Research; Hydraulic Engi-
neering for Improved Water Management,
15-19 August 1977, Baden-Baden, Federal
Republic of Germany, 2:271-278.

In the mouth of the Oosterschelde, an
estuary in the southwestern part of The
Netherlands, a movable storm surge bar-
rier, closed only during a storm, will be
built. To solve the hydraulic problems,
one of the items needed is a simulation of
the tide in that area. Therefore simul-
taneously a hydraulic (tidal) model and a
one-dimensional mathematical model are
used, both of which are described here.
The total area represented by the models
is about 180,000 acres. The hydraulic
model has a fixed bottom and is distorted:
the horizontal scale n_l = 400 and the
vertical scale n_d = 100 . In the mathe-
matical model, the area is schematized by
a network of one-dimensional tidal chan-
nels. The model approximates by its many

sections and knots the two-dimensional
situation, leaving out of consideration
the fall of water levels owing to the
Coriolis force. The method used for com-
puting the tidal motion is the so-called
third implicit method. The models are
calibrated on a prototype tide, namely,
the tide of September 11, 1968. Both the
horizontal and the vertical tide are in
good correspondence with the prototype.
The hydraulic model is mainly used for
measuring the boundary conditions for
detail models, defining the changes in
velocity at places important for the envi-
ronment, and defining the dispersion of
fresh water in the salt water of the estu-
ary by predominantly convective transport.
The mathematical model is used, among
other things, for defining the relation
between the tidal range in the estuary and
the effective cross section of the storm
surge barrier available. In addition, the
mean stream velocities in the channels are
computed, and also the translatory waves,
which can appear by closing the storm
surge barrier. References (4 items).

Sündermann, J., and Elahi, K. Z. 1979.
"Constructional Effects on the Dynamical
Processes in a Tidal Inlet," Hydraulic
Engineering in Water Resources Development
and Management, Proceedings, Eighteenth
Congress, International Association for
Hydraulic Research, Cagliari, Italia,
10-14 September 1979, 4:215-221.

Different constructional alternatives for
a harbor in the Bight of Sonmiani, Paki-
stan, are investigated by means of a
hydrodynamical-numerical model. Due to
the very poor field data available, the
boundary values are obtained from a hier-
archy of nested models for the tides in
the Arabian Sea. Reference (1 item).

Sündermann, J., and Holz, K.-P., ed. Mathe-
matical Modelling of Estuarine Physics,
Lecture Notes on Coastal and Estuarine
Studies. (See complete entry in Sec-
tion I.)

Sündermann, J., and Krohn, J. "Numerical
Simulation of Tidal Caused Sand Transport
in Coastal Waters." (See complete entry
in Section II.)

Sündermann, J., Vollmers, H., and Berndt, D.
"Protection Against Storm Surges in a
Tidal River." (See complete entry in Sec-
tion I.)

Sündermann, J., Vollmers, H., and Puls, W.
1978. "The Influence of Dune and Flow
Parameters on the Friction Factor," Pro-
ceedings, Sixteenth Coastal Engineering
Conference, August 27-September 3, 1978,
Hamburg, Germany, ASCE, II:1787-1800.

Taking for example the flow over a ripple,
some results of a hydrodynamic numerical

model are presented and compared with experimental results. Special importance is attached to the pressure. On the basis of the equations used, the physical reason for the horizontal pressure gradient is investigated. The influence of some dune and flow parameters on the friction is examined. References (6 items).

Svasek, J. N., and Versteegh, J. 1977. "Mathematical Model for Quantitative Computations of Morphological Changes Caused by Man-Made Structures Along Coasts and in Tidal Estuaries," Proceedings, Seventeenth Congress of the International Association for Hydraulic Research; Hydraulic Engineering for Improved Water Management, 15-19 August 1977, Baden-Baden, Federal Republic of Germany, 4:189-198.

The mathematical model TRAM9/TAPRAM is based upon refraction computations (TRAM9) and computations of energy-flux-losses (TAPRAM) of the statistically distributed significant wave heights. It is set up for calculations of the sediment transport capacity of breaking waves between depth contours along a coast. The model is twice calibrated by hindcasts of morphological changes along the artificial coastline of the Europort land reclamation. Comparison of the results of the two hindcasts with the volumetric changes computed from soundings showed a difference of approximately 30 percent for the maximum resulting transports which were in the order of 800,000 m³ in a period of 15 months and 300,000 m³ in a period of 2.5 months, respectively. References (4 items).

Swakon, E. A., Jr., and Wang, J. D. 1977. "Modeling of Tide and Wind Induced Flow in South Biscayne Bay and Card Sound," Sea Grant Technical Bulletin No. 37, University of Miami, Coral Gables, Fla.

A recently developed model using the finite element technique to solve the vertically integrated equations of motion and continuity was applied to South Biscayne Bay and Card Sound to investigate the wind- and tide-induced flow. The time integration scheme of this model was modified by using the trapezoidal rule to improve computational efficiency. With this new scheme, greater time steps can be used; however, the model seems more susceptible to instability by resonance. A grid consisting of 105 elements and 73 nodes was designed to investigate the transient flow in the bay. Six different combinations of tide and wind forcing are presented. Tide and wind data were collected over a 4-month period to determine model boundary conditions. Tide gages were installed at six locations on the bay side of the ocean-bay boundary to provide time series of water surface elevations. Wind data were obtained from Miami Inter-

national Airport and Homestead Air Force Base. A comparison of the records from the two stations for the month of November revealed no significant spatial variation, and it was therefore assumed that the wind field over Biscayne Bay as a first approximation is uniform. Preliminary analysis of the tide data showed significant differences in both tidal ranges and phase lags from the average conditions as presented in the tide tables. Through analysis of the wind and tide data, an estimate of the wind-induced setup was found to be 7.6 cm (3 in.) from Cape Florida to Adams Key for an average 7.5-m/sec wind from the north. Similarly a setdown of 5.1 cm (2 in.) was found for a 5.0-m/sec wind from the south. The inclusion of these wind-induced surface gradients into the model forcing was found to have an important effect on predicted residence times. Predicted velocity patterns and "Lagrangian particle" drifts are presented for average spring and neap tide conditions with and without wind. Estimates of flushing times based on these results are also given. The convective transport in the bay system was found to be strongly influenced by wind whereas normal tidal variations played a minor role. References (20 items).

Swenson, E. M., and Chuang, W.-S. "Tidal and Subtidal Water Volume Exchange in an Estuarine System." (See complete entry in Section VIII.)

Swift, M. R. 1980. "Spatially Varying Turbulence Production in Tidal Channels," Marine Forecasting: Predictability and Modelling in Ocean Hydrodynamics; Proceedings, 10th International Liège Colloquium on Ocean Hydrodynamics, J. C. J. Nihoul, ed., Elsevier Oceanography Series 25, Elsevier, Amsterdam.

Effects of spatially varying turbulence production in tidal channels are calculated using an analytical model. The model is developed from the boundary layer form of the equation of motion and an eddy viscosity representation for Reynolds shear stress. The eddy viscosity is calculated using the turbulence kinetic energy equation. A perturbation method is applied to solve for turbulence kinetic energy and the vertical distribution of current. It is found that when turbulence production is spatially varying, advection of the inhomogeneous turbulence field introduces an asymmetric time dependence into the effective viscosity. One result of the hysteresis in the stress current relationship is the formation of residual currents. References (26 items).

Thatcher, M. L., and Harleman, D. R. F. 1981. "Long-Term Salinity Calculation in Estuaries," Journal,

Environmental Engineering Division, ASCE, 107(EE1):11-27.

A mathematical model of time-varying salinity distribution is selected and further developed for the purpose of calculating over a period of time equal to a year or more. These calculations are required to evaluate the effects of different scenarios or plans involving reservoir regulation and consumptive freshwater withdrawals. The tidal estuary portion of the Delaware River is the subject of this application. A hydrodynamic and coupled salinity model is described in terms of its governing equations. The model is one-dimensional and contains a dispersion relationship which is predictive over a broad range of tidal and freshwater inflow conditions. Treatment of boundary conditions is described with respect to the processing of large amounts of data and with respect to the definition of the salinity concentration of tributary and upstream inflows. A comparison is given between calculated and observed concentrations over a yearlong period. References (17 items).

Thienpont, M., and Berlamont, J. 1978. "Mathematical Modelling of Thermal Discharge in Rivers and Estuaries," Papers, 7th International Harbour Congress, K.V.I.V. (Royal Society of Flemish Engineers), Antwerp, Belgium, 22-26 May 1978, I:6.01/1-6.01/10.

The program is a first step in the study of a mathematical model of the near field zone of a thermal discharge. To proceed to the calculations, the method of finite elements was used first of all with triangular elements, whereby the reliability of the results has been checked on a physical model (rectangular channel). To obtain greater generality, isoparametric elements with a variable number of nodes was used. References (15 items).

Timmerman, H. "Forecasting Meteorological Effects on Water Levels on a Routine Basis with a Numerical Model." (See complete entry in Section I.)

Tucci, C. E. M., and Chen, Y. H. 1981. "Unsteady Water Quality Model for River Network," Journal, Water Resources Planning and Management Division, ASCE, 107(WR2):477-493.

A complex river network system consisting of branches and loops is sometimes complicated by downstream effects from tides, lakes, and other factors. The management of water quality in such rivers is a difficult task. A model was developed to simulate hydraulic behavior and water quality of a river network on a one-dimensional representation. The two complete St. Venant equations and the

transport equation were solved by a finite difference implicit method using a modified Gauss elimination procedure. The model can simulate biochemical oxygen demand, dissolved oxygen, and any conservative substance. The hydraulic module of the model was adjusted and verified with data from the Jacui Delta, Brazil, showing good agreement between the calculated results and the observed data. The water quality model was tested under hypothetical conditions for the same delta to demonstrate the utility of the model in making managerial decisions. References (10 items).

Turner, K. A., and Durham, D. L. 1984. "Documentation of Wave-Height and Tidal Analysis Programs for Automated Data Acquisition and Control Systems," Miscellaneous Paper HL-84-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Detailed documentation of two major programs, Wave Height and Tidal Analysis, for the Automated Data Acquisition and Control Systems (ADACS) is presented in this report. The Wave-Height program is used to analyze model data from hydraulic wave models and calculates various statistical parameters of wave height for specified model tests at selected locations in the model. Similarly, the Tidal Analysis program analyzes model data from hydraulic tidal models and calculates various tidal parameters for specified model tests at selected locations in the model. For each of these programs, the program functions, specifics, input (output), listing, tape formats, etc., are discussed in detail.

Uncles, R. J. 1981. "A Note on Tidal Asymmetry in the Severn Estuary," Estuarine, Coastal and Shelf Science, 13(4):419-432.

A one-dimensional, nonlinear numerical model is used to investigate the tidally averaged frictional stress and setup of water level due to tidal asymmetry in the Severn Estuary; these quantities depend on the overtides in the region. A linearized model of the overtides is applied to calculations of the M_4 currents in order to delineate the mechanisms responsible for their generation. The relative importance of individual nonlinear mechanisms to the tidally averaged stress and setup is determined; these mechanisms are interactions between tidal flow and changes in depth or breadth over a cross section, frictional interaction between the tidal flow and Stokes drift, interaction between the tidal fluctuations in water depth and frictional retardation and nonlinear advection. References (8 items).

Uncles, R. J. 1982. "Residual Currents in the Severn Estuary and Their Effects on

Dispersion," <u>Oceanologica Acta</u>, 5(4):403-410.

Depth-averaged residual currents and associated water levels resulting from M_2 tidal oscillations in a numerical model of the Severn Estuary, UK, are presented. Current patterns are dominated by eddies. Residual currents produce enhanced transverse and axial dispersion by the mechanism of tidal "random walk." The axial dispersion coefficient due to residual current eddies is shown to be comparable to the observed long-term value for the seaward section of estuary considered, and is much greater than values which can be attributed to vertical shear in tidal and residual currents, or transverse shear in tidal currents. Transverse mixing due to tidal "random walk" is found to be much greater than that which can be attributed to other known mechanisms. Estuarine width is shown to be important in that it limits the size of horizontal eddies, and therefore controls the dispersion for given tidal and residual current speeds. References (25 items).

Uncles, R. J., and Jordan, M. B. 1980. "A One-Dimensional Representation of Residual Currents in the Severn Estuary and Associated Observations," <u>Estuarine and Coastal Marine Science</u>, 10(1):39-60.

A one-dimensional hydrodynamical model is used to describe the cross-sectionally averaged Stokes drift and Eulerian residual (tidally averaged) currents in a section of the Severn Estuary between Porthcawl ~nd Sharpness. Residual variables are cu ~ed for periodic M_2 tides, and as functions of time during simulated spring-neap cycles. The results for periodic M_2 tides show that the landward-directed Stokes drift has a spatially averaged value of 3.5 cm s^{-1} in the Severn Estuary, which, in the absence of freshwater inputs and meteorological perturbations, is balanced by seaward-flowing Eulerian residual currents. The residual setup of water (i.e., the mean surface elevation relative to the value at the seaward boundary) is mainly determined by the magnitudes of the axial density gradients and friction, with the friction dominating for typical salinity distributions; the landward flow of water due to the Stokes drift contributes to the setup, which drives the seaward residual currents against the opposing frictional forces. It is shown that the magnitude of the Stokes drift is mainly determined by the estuary's geometry, the strength of the tidal streams, and the friction (regardless of whether a quadratic or linearized friction law is assumed), the effects of density gradients and axial momentum advection and dispersion being negligible. The frictional dissipation in the Severn Estuary, which amounts to 3 $\cdot$ 10^9 watts

for M_2 tides in the region between Porthcawl and Sharpness, is balanced by a landward residual flow of energy across the mouth, which is very nearly proportional to the Stokes drift at the mouth. The axial residual currents and Stokes drift have maximum and minimum speeds at spring and neap tides, respectively, the speeds at average spring tides being roughly seven times those for average neap tides, and twice those for M_2 tides. The neap to spring part of the tidal regime is a period of increasing estuarine residual volume and landward-flowing Lagrangian residual currents (~1 mm s^{-1} near the mouth); the reverse is true for spring to neap tides. The computed values of the Stokes drift are compared with observations at nine anchor stations and covering 28 tidal cycles; the agreement between observations and theory is generally good. References (22 items).

van de Kreeke, J., and Chiu, A. A. "Tide-Induced Residual Flow in Shallow Bays." (See complete entry in Section I.)

van de Kreeke, J., and Wang, J. D. 1978. "Tidal Hydraulics and Salt Balance of Lake Worth, Florida," <u>Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany</u>, ASCE, III:2827-2839.

During the rainy season large quantities of fresh water are discharged through the canals into the estuaries surrounding the Florida coast, resulting in a considerable lowering of the salinities. The following specific problems are addressed in this paper: identification and quantification of freshwater sources; determination of freshwater/saltwater transport mechanisms and the resulting salinity distribution; and the effect of reducing the freshwater inflow on the flushing time. For this purpose a series of field measurements was carried out and mathematical models describing the hydrodynamics and salinity distribution were developed. References (4 items).

van de Ree, W. J., Voogt, J., and Leendertse, J. J. "A Tidal Survey for a Model of an Offshore Area." (See complete entry in Section VII.)

Vongvisessomjai, S., and Srikanthan, R. "The Regimen of Takuapa Tidal Channel." (See complete entry in Section I.)

Vreugdenhil, C. B. "Application of Finite-Difference Methods to Estuary Problems." (See complete entry in Section I.)

Walters, R. A., and Cheng, R. T. 1978. "A Two-Dimensional Hydrodynamic Model of a Tidal Estuary," <u>Proceedings, Second International Conference on Finite Elements in</u>

Water Resources, Imperial College, London, July 1978, 2.3-2.21.

This paper describes a finite element model which is used in the computation of tidal currents in an estuary. This numerical model is patterned after an existing algorithm and has been carefully tested in rectangular and curve-sided channels with constant and variable depth. One of the common uncertainties in this class of two-dimensional hydrodynamic models is the treatment of the lateral boundary conditions. Special attention is paid specifically to addressing this problem. To maintain continuity within the domain of interest, "smooth" curve-sided elements must be used at all shoreline boundaries. The present model uses triangular, iso-parametric elements with quadratic basis functions for the two velocity components and a linear basis function for water surface elevation. An implicit time integration is used and the model is unconditionally stable. The resultant governing equations are nonlinear owing to the advective and the bottom friction terms, and are solved at each time step iteratively by the Newton-Raphson method. Further model test runs have been made in the southern portion of San Francisco Bay, California, USA (South Bay), where a two-dimensional model is justifiable. Due to the complex bathymetry, the hydrodynamic characteristics of South Bay are dictated by the generally shallow basin which contains deep, relict river channels. Great care must be exercised to ensure that the conservation equations remain locally as well as globally accurate. Simulations have been made over several representative tidal cycles using this finite element model and the results compared to existing data. References (27 items).

Walther, A. W. "Hydraulic Research in the Oosterschelde Estuary." (See complete entry in Section I.)

Walton, R., Granat, M. A., and Shubinski, R. P. 1980. "Calibrating the Chesapeake Bay Circulation Model?" _Proceedings, Specialty Conference on Computer and Physical Modeling in Hydraulic Engineering_, McCormick Inn, Chicago, Illinois, August 6-8, 1980, ASCE, 387-396.

The discussion in this paper centers around the future calibration of a three-dimensional, numerical, circulation model being developed for the Environmental Protection Agency to model the bay and its tributaries. The authors attempt to identify its important calibration parameters, and review similar coefficients used in previous models and measured in the field. Finally, the calibrations and areas of applicability of this model are compared with the Corps of

Engineers hydraulic model located at Matapeake, Maryland. References (17 items).

Wang, D. P. "Two-Dimensional Branching Salt Intrusion Model." (See complete entry in Section III.)

Weisman, R. N., Collins, A. G., and Parks, J. M. 1982. "Maintaining Tidal Inlet Channels by Fluidization," _Journal, Waterway, Port, Coastal and Ocean Division_, ASCE, 108(WW4):526-538.

Along the barrier islands off the east coast of the United States and at other areas of the world, there exist many tidal inlet channels which connect the ocean to back bay areas. An innovative technique is tested to maintain a stable, navigable channel. Water is pumped into a perforated pipe buried beneath the sand, and the water flowing through the perforations fluidizes the overlying sand. The fluidized sand along the pipe is then removed either by gravity flow, slurry pump, or entrainment in the overlying ebb tidal current. Laboratory experiments provided information necessary for the design of such a fluidization system, specifically, data on hole orientation, hole size, hole spacing, flow rate necessary for fluidization, and the effect of slurry removal on the channel shape. A small-scale field test, designed from the laboratory data and performed on a beach face, shows that the technique is technically feasible and that the design data are sound. In the field test, full fluidization along fluidization pipe was achieved and the fluidized sand was removed by pumping the slurry or, when the pipe was sloped, by gravity flow. References (11 items).

Welch, J. M., and Parker, B. B. "Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina." (See complete entry in Section I.)

Whalin, R. W. 1977. "Los Angeles Harbor and Long Beach Harbor: Plan of Study," _Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE_, Long Beach, Calif., March 9-11, 1977, I:1-9.

The US Army Corps of Engineers in concert with personnel from the Port of Los Angeles and the Port of Long Beach realized that major expansion plans for both ports should be accompanied by a comprehensive analysis, from both an engineering and environmental viewpoint, in order to ensure that the optimal plans for expansion were realized. Factors complicating this analysis included a lack of quantitative knowledge regarding (a) incident long wave energy levels, (b) response characteristics of the existing harbors complex, (c) existing circulation and flushing

conditions in the present harbor,
(d) mooring methods, (e) moored ship re-
sponse, and (f) effect of proposed ex-
pansion plans on all these factors.
A comprehensive study plan was developed
that included the following objectives:
(a) determine the incidence and severity
of troublesome oscillations in the pre-
sent harbor complex, (b) investigate tidal
circulation characteristics of the present
and improved harbors, (c) determine opti-
mum plans for future expansions to provide
safe and economical berthing areas, and
(d) analyze effects of proposed expansions
on existing harbors. Major elements of
the study plan were measurement of the
long-period wave climate in the harbors;
observations of moored ship response in
the existing harbors; design and con-
struction of a hydraulic model and neces-
sary model equipment; use of appropriate
numerical models of ship response, tidal
circulation, and harbor response; and
conduct of hydraulic model tests to define
the existing and future harbor response to
long-period energy and to study circula-
tion and flushing of the existing and im-
proved harbors. It is envisioned that the
hydraulic model and associated numerical
models can be used to study effects of a
multitude of related developments in the
area from Point Fermin to Huntington
Beach. Some such potential studies in-
clude the effect of proposed future dis-
charges (LNG discharge, sewer outfalls,
power plant discharges, etc.) on tidal
circulation and flushing, tsunami effects
(both distant and local seismic events),
methods of improving circulation and
flushing in Bolsa Chica Wildlife Reserve
and the Huntington Harbor development,
swell and circulation design criteria for
small craft harbors and for potential
Naval developments, and design criteria
for development of the shelf area seaward
of the existing breakwaters (offshore air-
port, future port developments, etc.).

Whalin, R. W. 1977. "Los Angeles Harbor
and Long Beach Harbor: Summary of Results
and Future Plans," Ports '77, 4th Annual
Symposium of the Waterway, Port, Coastal
and Ocean Division of ASCE, Long Beach,
Calif., March 9-11, 1977, I:169-177.

An extremely complex study plan has
evolved during the past 5 years; and vast
quantities of hydraulic model, numerical
model, and prototype data have been gener-
ated. The objective of this paper is to
summarize results of all these studies,
delineate the relation of each element to
the overall study plan, and describe fu-
ture plans in this investigation. Proto-
type wave measurements from 6 sec to the
tidal period have culminated in the most
comprehensive and most successful data
base ever obtained on long-period waves.
Simultaneous observations of moored ship

response, measurement of long-period
waves, numerical computations of moored
ship response, numerical harbor oscilla-
tion studies, and hydraulic model data on
harbor oscillations have resulted in a
comprehensive understanding of oscilla-
tions both in the existing harbor complex
and for various proposed improvement
plans. The verified hydraulic and numeri-
cal tidal circulation models, coupled with
the computation of residence times for
various basins and subbasins in the har-
bors, have provided a quantitative knowl-
edge of circulation conditions in the
existing harbors and for proposed improve-
ment plans. Consequently, proposed im-
provement plans can be formulated in order
to optimize the compatibility of safe and
economical berthing areas with environ-
mentally acceptable water quality condi-
tions in the harbor complex. As a result
of the studies conducted by the Corps of
Engineers, the Port of Los Angeles, and
the Port of Long Beach for the purpose of
assuring optimal functional and environ-
mentally compatible development of the
harbors, the Los Angeles and Long Beach
Harbors complex has undoubtedly become the
best understood and most studied major
harbor complex with respect to harbor
oscillations, tidal circulation, and
flushing. The hydraulic model has been
referred to as the "living model," which
is especially appropriate in view of its
ability to be used to quantitatively
investigate the effect of future plans as
they evolve from the constantly changing
requirements of the various political
entities and private developments associ-
ated with San Pedro Bay. Potential use of
the model for future studies of San Pedro
Bay truly appears to be endless. The
model can be ideally used as a tool for
the planning, design, operation, and
maintenance of practically all water
quality-related developments, harbor os-
cillation problems, coastal or offshore
structures, and many related studies of
either small craft harbors or coastal evo-
lution. References (16 items).

Wilkinson, D. L. 1978. "Periodic Flows
from Tidal Inlets," Proceedings, Sixteenth
Coastal Engineering Conference, August 27-
September 3, 1978, Hamburg, Germany, ASCE,
II:1336-1346.

A study was undertaken of the flow pro-
duced in the offshore region by tidal cur-
rents at the entrance of a coastal inlet.
The gross features of the offshore flow
structure were examined in an idealized
two-dimensional model in which a sinusoi-
dally reversing flow was discharged from
an open channel into a large stagnant
basin. During each period of ebb flow,
the discharge from the simulated inlet
developed a structure very similar to that
of a starting jet, and a vortex pair was

observed to form and ultimately became the dominant feature of the flow. Although variable bottom topography and longshore currents will distort the flow pattern, the rotational motions observed in these experiments would be expected to persist. The study was restricted to coastal inlets in which the sectional area of the entrance channel is several orders of magnitude smaller than the area of water surface inside the inlet. Reference (1 item).

Winterwerp, J. C. "Decomposition of the Mass Transport in Narrow Estuaries." (See complete entry in Section III.)

Wolanski, E. "The Fate of Storm Water and Stormwater Pollution in the Parramatta Estuary, Sydney." (See complete entry in Section III.)

Wong, K.-C. "Subtidal Volume Exchange and the Relationship to Atmospheric Forcing in Great South Bay, New York." (See complete entry in Section I.)

Wong, K.-C., and Wilson, R. E. "An Assessment of the Effects of Bathymetric Changes Associated with Sand and Gravel Mining on Tidal Circulation in the Lower Bay of New York Harbor." (See complete entry in Section I.)

Wood, T. 1980. "Discrete-Time Modelling of Dispersion in Estuaries," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:3078-3086.

This paper aims to put forward a case in favor of a simple discrete-time model describing mixing in an estuary. The model derives from the remarkably simple concepts developed by Ketchum (1951) which describe mixing in terms of tidal prism exchanges between segments. The author's view is that Ketchum's ideas were abandoned before they were fully explored. A major factor was the advent of the high-speed computer which opened up the possibility of using an approach based on the space-time formulation of the problem in terms of the partial differential equations of transport theory. Intrinsically this approach, based on a continuum description, is more attractive than a gross description based on relatively large segments: one obvious reason is the possibility of providing a comprehensive space-time prediction of the spread of a pollutant. In practice, though, significant problems arise in its use. In particular, the following can be mentioned: (a) substantial computing costs relating to computer program development and machine time; (b) specification of transport parameters inherent in the partial differential equations of transport: for example, dispersion coefficients; and (c) model validation and state/parameter estimation. The last of these is the primary concern of this paper. It is probably true to say that, to date, too little attention has been given to these topics, in the context of estuarine modelling. The point to be made is that there is small justification in using a sophisticated description of a system if the resulting predictions of the model cannot be effectively validated. The ideas used in this paper stem from those put forward by Beck and Young (1975) in studies on nontidal river pollution. The subsequent discussion suggests an extension to estuarine systems. References (6 items).

SECTION VII. SURVEYS AND INSTRUMENTS

Methods and techniques of field surveys, observation

sampling, measurements, and data collection, and various types of

instruments, gages, and sampling devices.

Bohlen, W. F., and Marine Sciences Department, University of Connecticut. "A Comparison Between Dredge Induced Sediment Resuspension and That Produced by Natural Storm Events." (See complete entry in Section II.)

Blair, C. 1983. "Tidal Corrections in Hydrographic Surveying," Journal, Waterway, Port, Coastal and Ocean Engineering, ASCE, 109(1):31-40.

Depth errors may occur in hydrographic surveys if tidal corrections are determined from water surface heights measured at points distant from the immediate vicinity of the soundings. Use of predicted rather than measured heights is another potential cause of error. Errors are presented for a hypothetical calculation of dredging pay quantities. Procedures for reducing errors are suggested, and methods of measuring tide height described. References (7 items).

Breusers, H. N. C., and van Os, A. G. "Physical Modelling of the Rotterdamse Waterweg Estuary." (See complete entry in Section VI.)

Chelton, D. B., Jr. "Low Frequency Sea Level Variability Along the West Coast of North America." (See complete entry in Section VI.)

Christiansen, H., and Siefert, W. "Storm Surge Prediction by Combined Wind and Tide Data." (See complete entry in Section VIII.)

Dandy, G. C., Mills, D. A., and Hinwood, J. B. "Water Movement Studies Required for Port Planning." (See complete entry in Section I.)

Davies, A. M. "Role of 2D and 3D Models in JONSDAP '76." (See complete entry in Section VI.)

Diamante, J. M., et al. 1982. "Tidal and Geodetic Observations for the SEASAT Altimeter Calibration Experiment," Journal of Geophysical Research, 87(C5):3199-3206.

A calibration experiment for the SEASAT radar altimeter was conducted in the Bermuda calibration area during September and October of 1978 by a group of Federal Government agencies, universities, and research organizations. As part of the SEASAT calibration activities, a tide gage was installed by the National Ocean Survey at an open coastal location on Bermuda to provide a determination of the instantaneous sea surface height during the SEASAT overflights of the island. The tide gage was geodetically tied to the laser tracking station on Bermuda, so that SEASAT's position relative to the sea surface could be determined independently and compared with the value provided by the altimeter measurements. The root sum square error in the determination of the vertical position of the laser, relative to the sea surface, has been estimated to be 4.0 cm exclusive of possible errors arising from the present lack of precise information on the elevation of the geoid at Bermuda. References (10 items).

Dyer, K. R. 1980. "The Mixing Processes in a Partially Mixed Estuary: Southampton Water," Proceedings, Second International Symposium on Stratified Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:934-943.

Measurements have been carried out in Southampton Water using four current meters in the vertical, with regular temperature and salinity profiles and continuous salinity and temperature measurements close to the halocline. These revealed that a Richardson number $R_i < 0.25$, indicative of turbulent mixing, occurred for only short periods of the tidal cycle at high velocities. Mixing was shown by the spectra of salinity fluctuations to occur with velocities in excess of 15 cm sec^{-1}. This mixing may result from the presence of standing internal waves created by a lateral seiche, interacting with the velocity shear close to the seabed. References (9 items).

Egan, J. T., and Jones, H. L. 1967. "Tidal Measurement, Analysis, and Prediction," Report No. RN-28, Experimental Astronomy Laboratory, Massachusetts Institute of Technology, Cambridge.

For HYSURCH (Hydrographic Surveying and Charting System) survey operations, tidal analysis is necessary in order to establish a datum plane reference for depth soundings and to provide a basis for long-range tide predictions. Because of the brevity of the survey, conventional analysis techniques must be replaced by more approximate methods. The primary sources of tidal energy are reviewed, and the accuracy with which their effect can be predicted is estimated. Special attention is given to meteorological interference and local tidal anomalies. Section II gives a brief description of the instrumentation required for tidal measurements and the telemetry requirements. It includes a survey of existing instrumentation and design recommendations. The need for lightweight systems and rapid deployment techniques is emphasized.

Essen, H.-H., Gurgel, K.-W., and Schirmer, F. "Tidal and Wind-Driven Parts of Surface Currents, as Measured by Radar." (See complete entry in Section I.)

Evans, J. J., and Pugh, D. T. "Analysing Clipped Sea-Level Records for Harmonic Tidal Constituents." (See complete entry in Section I.)

Filloux, J. H., and Snyder, R. L. "A Study of Tides, Setup and Bottom Friction in a Shallow Semi-Enclosed Basin; Part I: Field Experiment and Harmonic Analysis." (See complete entry in Section VIII.)

Fornerino, M., and Chabert d'Hieres, G. "Study of M_2 Tidal-Currents in the English Channel Using the Physical Model at Grenoble." (See complete entry in Section VI.)

Gatto, L. W. "Estuarine Processes and Intertidal Habitats in Grays Harbor, Washington; A Demonstration of Remote Sensing Techniques." (See complete entry in Section I.)

Glen, N. C. 1979. "The Tidal Survey of the British Isles," Symposium on Long Waves in Ocean, June 6-8, 1978, Marine Sciences Directorate, Manuscript Report Series No. 53, Department of Fisheries and the Environment, Ottawa, Ontario, 18-22.

The survey began on the east coast of Norfolk and has proceeded in clockwise direction around the English coast. Each year, except when such events as the fuel crisis in the United Kingdom have prevented operations, a section of coastline has been carefully surveyed. The length of coast has depended on the complexity of the tidal regime in the area. The result of this work was a series of time and height differences which were, as far as possible, independent of meteorological effects.

Graff, J., and Karunaratne, A. 1980. "Accurate Reduction of Sea Level Records," International Hydrographic Review, 57(2):151-166.

The established procedures for the reduction of tide gage sea level records have been critically reviewed and adapted for systematic processing. Various new methods have been developed for screening and verification of digitized sea level data, and a computer-based system has been developed to process and archive these data in a uniform fashion. The system, intended for the routine processing of the class A network of tide gages around the British Isles, presents a new level of standards in the processing of coastal sea level records. References (7 items).

Haury, L. R., et al. "Tidally Generated High-Frequency Internal Wave Packets and Their Effects on Plankton in Massachusetts Bay." (See complete entry in Section VIII.)

Hawley, N. "Intertidal Sedimentary Structures on Macrotidal Beaches." (See complete entry in Section I.)

Hinwood, J. B., and Colman, R. S. 1978. "Use of an Echo Sounder to Map Vertical Stratification in an Estuary," Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:231-236.

Ship-borne echo sounders are being used to obtain longitudinal profiles of density discontinuities in the Yarra River. The echo sounders are commercially available units operating near 200 kHz. The records obtained reveal details of the vertical structure of salinity, temperature, and silt concentration. Small sharp interfaces show up clearly while larger, more gradual gradients do not. Typical results and some limitations are presented. References (3 items).

Howarth, M. J. 1980. "Intercomparison of Current Meters in Fast Tidal Currents," Report No. 94, Institute of Oceanographic Sciences, Birkenhead, U.K. (Unpublished Manuscript).

Six Aanderaa and three vector-averaging current meters were deployed for 1 month in water 45 m deep where the M_2 tidal current has an amplitude of 0.8 m/s. The mean flow was less than 0.04 m/s, but there were two storm surges with currents up to 0.15 m/s. There was good agreement between the meters for tidal and surge currents and in the main for low-frequency currents, but an Aanderaa and an American Machine and Foundry, Inc., vector averaging current meter (AMF VACM) with rotors 1.5 m apart showed poor agreement for low-frequency currents in the direction perpendicular to the tidal flow. References (17 items).

Howell, G. 1980. "Florida Coastal Data Network," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, I:421-431.

The application of wave and tide data to coastal engineering problems has been demonstrated frequently by university and government research organizations. However, problems faced by practicing coastal engineers are often solved without recourse to such data, since it is frequently not available for the required location. The high cost and low reliability of long-term wave measurement is the primary factor limiting the wider application of analysis techniques requiring wave energy and wave direction parameters. In order to improve this situation, several organizations, notably the US Army Corps of Engineers Coastal Engineering Research

Center (CERC) (Peacock 1974), and the Cal-
ifornia Department of Navigation and Ocean
Development (Seymour 1976), have employed
advanced electronics and computer tech-
niques to reduce the cost of wave measure-
ment. The Florida Coastal Data Network
(CDN) is a similar effort which, due to
the special problems of Florida wave cli-
mate, has employed advanced instrumenta-
tion not only to reduce cost, but to pro-
vide additional capability. Like other
tropical and subtropical regions, Flor-
ida's coastal environment is characterized
by relatively infrequent but severe tropi-
cal storms. In many coastal engineering
applications, the specification of the
hurricane-associated storm surge and storm
waves will be the major design criteria.
The Florida CDN was created in order to
provide field measurements of waves and
tides year round as well as during hurri-
canes. References (3 items).

Huntley, D. A., and Nummedal, D. 1978.
"Velocity and Stress Measurements in a
Tidal Inlet," Proceedings, Sixteenth
Coastal Engineering Conference, August 27-
September 3, 1978, Hamburg, Germany, ASCE,
II:1320-1335.

Fast-response electromagnetic flowmeters
were used in a marginal flood channel of
an ebb tidal delta to assess the impor-
tance of wave contributions to the flood
dominance of these channels. Measurements
were made at a single point in the channel
in both ebb and flood currents. The os-
cillatory motion of waves was a very sig-
nificant feature of the velocity records,
and its magnitude was comparable with the
mean flow at all stages of the tide. This
observation shows that flowmeters capable
of responding accurately to wave veloci-
ties are needed to obtain accurate values
of mean flow. Some earlier measurements
made with slow-response flowmeters are
probably unreliable. Wave contributions
to the mean flow were assessed by looking
at the correlation between the low fre-
quency (>17.5 sec) oscillations of the
along-channel current and the low fre-
quency envelope of the wave velocities.
Surprisingly little correlation was found
for any time lag, suggesting that wave
effects were not important in the mean
tidal currents in the channel studied.
However, close to low tide on the ebb,
conditions existed which appear to have
been favourable for the "wave pump" mech-
anism suggested by Bruun and Viggisson.
Significant correlation between the wave
envelope and low frequency fluctuations
was observed at this time. It is there-
fore suggested that wave effects can be
important to the mean flow in marginal
channels with rapidly converging and
shoaling mouths which are oriented toward
the dominant incident wave direction.
References (13 items).

Kato, M. "Observation of Crustal Movements
by Newly-Designed Horizontal Pendulum and
Water-Tube Tiltmeters with Electromagnetic
Transducers (2)--Variations in the Ampli-
tude and Phase of Tidal Tilts Observed
with a Water-Tube Tiltmeter at Kamita-
kara." (See complete entry in Section I.)

Khorram, S. 1982. "Remote Sensing of Sa-
linity in the San Francisco Bay Delta,"
Remote Sensing of Environment, 12(1):15-
22.

Salinity of the San Francisco Bay Delta
has been studied for the past seven de-
cades. There is a significant gradient in
salinity within this estuarine system that
influences the growth and distribution of
phytoplankton as well as the abundance and
migration of shrimp and fish population.
Several government agencies which have
jurisdictions over this area are attempt-
ing to gather extensive data for effective
monitoring of this estuary. Repetitive
remotely sensed data acquired from Landsat
may be considered by these agencies as
having the potential to provide a cost-
effective method for gathering and pro-
cessing water quality related data. In
this study, Landsat multispectral scanner
(MSS) data and color and color infrared
photographs acquired from a U-2 aircraft
were combined with surface measurements
for salinity mapping of the San Francisco
Bay Delta. The salinity measurements and
U-2 photography were obtained simul-
taneously and coincident with Landsat
overpass. A regression model was devel-
oped between the surface truth data and
Landsat digital data for 29 preselected
sample sites and was then extended to the
entire study area. The results included
a salinity map of the study area and the
statistical summaries. The results were
in general agreement with the reported
distribution of salinity values in the
literature for the same time of the year.
Based on the results and the associated
analyses of natural color and color in-
frared photographs and Landsat color com-
posite imagery, it was concluded that:
(a) it was virtually impossible, at least
within this test site, to establish any
quantitative judgment regarding the salin-
ity values by visual interpretation of the
imagery; and (b) the present study consti-
tutes the first effort to successfully use
Landsat digital data for salinity mapping,
by means of digital processing, for this
geographic area. References (32 items).

Kjerfve, B. 1982. "Calibration of Estua-
rine Current Crosses," Estuarine, Coastal
and Shelf Science, 15(5):553-559.

Tethered current crosses are simple, reli-
able tools in making measurements of estu-
arine currents in the absence of surface
waves. The standard error of the estimate

of current speed is less than 5 cm sec^{-1} for the particular crosses and weights used in a calibration experiment. The useful velocity range of these current crosses was 8-147 cm sec^{-1}, corresponding to a measured angle, α , from 2° to 30°. Regression of the independently measured current speed on $(\tan \alpha)^2$ yielded coefficients of determination greater than 0.94, indicating that the drag coefficient is not a function of current speed. However, the calculated drag coefficients varied widely from 0.66 to 2.55, depending on the particular combination of cross and weight, varying drastically from the commonly assumed drag coefficient value of 1.12. Thus, in using current crosses, it is imperative to calibrate each cross against a current meter reading to determine an appropriate value for the drag coefficient for a particular current cross and weight. References (6 items).

Knight, D. W., et al. 1980. "The Measurement of Vertical Turbulent Exchange in Tidal Flow," Proceedings, Second International Symposium on Stratified Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:722-730.

Mathematical models are useful tools for predicting the effects that proposed engineering works will have on the movement of water, solutes, and suspended solids in estuaries. The predictive capabilities of these models are, however, strongly influenced by the representation of the principal physical processes being modeled. In particular, any numerical model concerned with the vertical structure of the flow depends heavily on the accuracy of its representation of the vertical turbulent exchange of mass and momentum. The objective of the research described in this paper was to measure the turbulent fluctuations in velocity in weakly stratified tidal flows in order to evaluate the vertical Reynolds stresses. The research was a planned extension of earlier field observations made in the presence of a marked halocline (Odd and Rodger 1978). Field measurements were considered more rewarding than laboratory experiments, which can suffer from scale effects, despite difficulties resulting from a lack of control over the conditions being measured. One of the objectives of the new work was to test the semi-empirical functions proposed by Odd and Rodger in cases of weakly stratified flows. References (3 items).

Knowles, C. E. 1981. "Estimation of Surface Gravity Waves from Subsurface Pressure Records for Estuarine Basins," Working Paper 81-6, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh.

This report presents two basic ways of measuring surface gravity waves in coastal and estuarine waters: one uses a surface wave profiler (e.g., continuous wire or step resistance gages) that produces a time series record that should represent the actual surface wave profile, while the other (a sensitive, subsurface pressure transducer) produces a time series of pressure fluctuations proportional to the elevation of the surface waves. According to small-amplitude theory, the surface gravity wave energy spectrum can be estimated from a subsurface pressure fluctuation spectrum by applying a factor K that compensates for the attenuation of surface wave amplitude as the depth below the water surface and the wave frequency increase. There are a number of linear and nonlinear environmental factors, however, that cause K to be invalid over most of the spectrum's frequency range. Numerous attempts have been made to empirically derive a valid correction factor n that could be applied to K to give a better estimate of the surface spectrum. This report discusses some of the reasons why the empirical factors vary so greatly and recommends Grace's (1978) equation for n as a function of the nondimensional frequency parameter kh (where $k = 2\pi/L$ is the local wave number, h the local depth, and L the wavelength) specifically for use in an estuarine environment. References (11 items).

Knowles, C. E. "Wind-Wave Climatology and Wind-Tides for Fort Raleigh Wave-Gauge Site, 1979." (See complete entry in Section VIII.)

Lees, B. J. "Observations of Tidal and Residual Currents in the Sizewell-Dunwich Area, East Anglia, U.K." (See complete entry in Section VIII.)

Le Fèvre, J., et al. "Remote Sensing Observations of Biological Material by LANDSAT along a Tidal Thermal Front and Their Relevancy to the Available Field Data." (See complete entry in Section VIII.)

Ludwick, J. C., and Johnson, P. B. 1977. "Hydraulic Sensor Instrumentation in a Shore Face in a Tidal-Nontidal Coastal Convergence Zone, Cape Henry, Virginia," Hydraulic Sensor Instrumentation of a Shore Face in a Tidal Current Convergence Zone--Cape Henry, Virginia, Technical Report No. 25, Institute of Oceanography, Old Dominion University, Norfolk, Virginia, Part I:1-106.

The question as to whether coastal currents are competent to erode unconsolidated and semiconsolidated sediments of sand size on the inner continental shelf is a subject of much ongoing research. The present investigation relates to this

question. Instrumentation and data analysis procedures are presented. The basic data-gathering technique planned for use in this study employs a rigid instrument platform installed on the sea floor. An armored cable is used to transmit sampled data to recording instruments on shore. The advantages and disadvantages of this system are compared in the report to the more conventional techniques of using surface vessels, radio-link buoys, and self-contained recording and storage within the sensor housing for periodic retrieval. The design, operation, and installation of the measurement system are discussed in detail. This includes the design, fabrication, and deployment of the sea floor platform, the selection and laying of the armored cable, and the design and theory of operation of the data acquisition system. The data acquisition system controller, a PDP-8E minicomputer, is discussed, and the documentation for a complete software package is provided. The data analysis methodology which uses the discrete Fourier transform (DFT) and the fast Fourier transform (FFT) to find the power spectral density is given along with an example of its application. References (21 items).

Milliman, J. D., et al. "Tidal Phase Control of Sediment Discharge from the Yangtze River." (See complete entry in Section II.)

Mills, D. A., Colman, R. S., and Dandy, G. C. 1978. "Water Movement in a Complex Estuarine Embayment--A Methodology for Data Collection and Analysis," Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:153-159.

The environmental assessment of Hobsons Bay required a detailed knowledge of water circulation and its response to tidal, wind, and riverine influences, each of which can be of comparable importance. In order to meet this requirement, an integrated program of data collection and analysis was developed and put into effect. This paper discusses some of the complementary monitoring techniques and methods of analysis which were employed. The program encompasses many variables, and its applicability may not be confined to only one location. References (4 items).

Nece, R. E. "Planform Effects on Tidal Flushing of Marinas." (See complete entry in Section VI.)

Nece, R. E., et al. "Effects of Planform Geometry on Tidal Flushing and Mixing in

Marinas." (See complete entry in Section VI.)

Novak, P., and Cábelka, J. Models in Hydraulic Engineering; Physical Principles and Design Applications. (See complete entry in Section VI.)

Onishi, S., and Nishimura, T. "Study on Vortex Current in Strait with Remote-Sensing." (See complete entry in Section VIII.)

Pickett, E. B., and Greer, H. C. "Los Angeles Harbor and Long Beach Harbor: Prototype Data Acquisition and Observations." (See complete entry in Section VIII.)

Prandle, D., et al. "The Use of Array Processors for Numerical Modelling of Tidal Estuary Dynamics." (See complete entry in Section VI.)

Pruszak, Z., and Zeidler, R. B. "Sediment Transport and Ripples Due to Waves and Currents." (See complete entry in Section II.)

Rives, S. R., and Pritchard, D. W. "Adaptation of J. R. Hunter's One-Dimensional Model to the Chesapeake and Delaware Canal System." (See complete entry in Section VI.)

Sharp, J. J. Hydraulic Modelling. (See complete entry in Section VI.)

Shelley, P. E. "Sediment Measurement in Estuarine and Coastal Areas." (See complete entry in Section II.)

Stacey, M. W. "The Interaction of Tides with the Sill of a Tidally Energetic Inlet." (See complete entry in Section I.)

Stigebrandt, A. "Some Aspects of Tidal Interaction with Fjord Constrictions." (See complete entry in Section I.)

Streif, H. "A New Method for the Representation of Sedimentary Sequences in Coastal Regions." (See complete entry in Section II.)

Sündermann, J., and Holz, K.-P. Mathematical Modelling of Estuarine Physics, Lecture Notes on Coastal and Estuarine Studies. (See complete entry in Section I.)

Swakon, E. A., Jr., and Wang, J. D. "Modeling of Tide and Wind Induced Flow in South Biscayne Bay and Card Sound." (See complete entry in Section VI.)

Thompson, R. O. R. Y. 1983. "Low-Pass Filters to Suppress Inertial and Tidal

Frequencies," Journal of Physical Oceanography, 13(6):1077-1083.

A systematic way is given to design digital filters which allow clear separation of signals with periods of a few days from noise of higher frequency, particularly tidal and inertial. Several examples are given which pass little high-frequency power and none at the principal tidal frequencies. The Lanczos-cosine filter passes too much energy near diurnal frequencies; the Godin filter is better but not optimal. A longer filter is recommended, with flat low-frequency response, a sharp cutoff, and very low noise. For current meter records containing inertial motions, it appears desirable to design a filter which specifically suppresses the local inertial frequency. References (6 items).

van de Ree, W. J., Voogt, J., and Leendertse, J. J. 1978. "A Tidal Survey for a Model of an Offshore Area," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2656-2670.

In support of engineering and environmental investigations for the construction of a storm surge barrier in the southwestern part of The Netherlands, the Randdelta II model was used in conducting this survey. An extensive field survey was made of tides and currents to establish the boundary conditions and to adjust and verify the model. The data from the water level recording stations were analyzed and the instrumentation for current and pressure recording is presented. In view of the importance of the pressure data obtained at the boundary of the model area for the studies, a detailed analysis of these data is given in this paper. References (3 items).

Wang, Y.-H. 1980. "Satellite Applications on a Coastal Inlet Stability Study," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2581-2594.

It is known that longshore drift of alluvial material occurs along sandy barrier islands. Inlets between these barrier islands intercept the normal littoral drift, resulting in a net loss of sand from the beaches. During a flood tide, sand is brought into the inlet and part of it is retained to form the inner bar; during ebb cycle, part of the sand is jetted out into the ocean to form an outer bar. The reversing flows of flood and ebb cycles may also cause deposition or scouring on the bottom of inlet channels. There are two sets of parameters pertinent to the behavior of inlets. The first set deals with the changes in the dynamic bottom configuration (i.e., the movement of inner and outer bars, the choking or scouring of the inlet channel). The second set of parameters regards the driving forces of the coastal system (i.e., wave climate, tide, wind, and currents). Understanding the interrelationship of these two sets of parameters leads to the solution of stabilizing the inlet. The time-sequential dynamic interrelationships and natural tendencies of inlets are well portrayed on available Landsat imageries. Mapping the sandbars and their movements is traditionally done by a sounding boat and survey team. The derived point and line information is then used to produce the contour map of the bottom. Extensive interpolations are needed because many details between the points and lines are missing. The operation is expensive and the procedures are time consuming. Techniques using remote sensing can be used to monitor the changes that take place, reducing costs and increasing efficiency. Even though standard procedures have not yet been established, the satellite sensing of bottom features has progressed considerably in recent years. Sherman (1975), Middleton and Barber (1976), Hubbard (1977), and Lyzenga and Thomson (1978) all demonstrated that it is possible to correlate the radiance values of multispectral images, such as Landsat imagery, with the depth-related information in shallow water. The present study is one more example of such an effort. References (6 items).

Weisman, R. N., Collins, A. G., and Parks, J. M. "Maintaining Tidal Inlet Channels by Fluidization." (See complete entry in Section VI.)

Welch, J. M., and Parker, B. B. "Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina." (See complete entry in Section I.)

Wells, J. T., Coleman, J. M., and Wiseman, W. J., Jr. "Suspension and Transportation of Fluid Mud by Solitary-Like Waves." (See complete entry in Section II.)

Williamson, A. N. "Movement of Suspended Particles and Solute Concentrations with Inflow and Tidal Action." (See complete entry in Section VIII.)

Yarbro, L. A., et al. "A Sediment Budget for the Choptank River Estuary in Maryland, U.S.A." (See complete entry in Section II.)

SECTION VIII. BASIC PHYSICAL DATA

Tide tables, datum planes, tidal current charts, and the
results, tabulation, and discussion of basic physical data ob-
tained from field surveys, investigations, and data collection
programs. Physical features of ports, harbors, estuaries, etc.,
when related to tidal hydraulic problems.

Abbott, M. B., Schrøder, H., and Warren, I. R. "Modelling of the Salinity Intrusion in the Sound Between Denmark and Sweden." (See complete entry in Section VI.)

Abraham, G. "On Internally Generated Estuarine Turbulence." (See complete entry in Section I.)

Ambrose, R. B., Jr., and Roesch, S. E. "Dynamic Estuary Model Performance." (See complete entry in Section VI.)

Amin, A., and Graff, J. 1980. "Some Notes on Simplifying the HSWC Method of Tidal Analysis," International Hydrographic Review, 57(2):167-173.

The method of least squares, as used in the Harmonic Shallow Water Correction (HSWC) technique by Amin (1977), is adapted under restrictions of fixed data length and specified constituents, imposed by Doodson's (1957) method. It is shown that the technique provides a quick and simple method of computing HSWC coefficients. Also some simple graphic explanation of the criteria for selection of data length, essential to resolve constituents having given speeds, is provided. References (3 items).

Anwar, H. O. "Turbulence Measurements in Stratified and Well-Mixed Estuarine Flows." (See complete entry in Section I.)

Anwar, H. O., and Weller, J. A. "An Experimental Study of the Structure of a Freshwater-Saltwater Interfacial Mixing." (See complete entry in Section III.)

Aston, S. R.. and Stanners, D. D. "The Transport to and Deposition of Americium in Intertidal Sediments of the Ravenglass Estuary and Its Relationship to Plutonium." (See complete entry in Section IV.)

Baliga, B. R., and Hudspeth, R. T. "Evaluation of Sand Waves in an Estuary." (See complete entry in Section IV.)

Basu, A. N. "Composite Mathematical Model of Saptamukhi River System Including Outfall Channels for Studying the Effect of Closure." (See complete entry in Section VI.)

Battisti, D. S., and Clarke, A. J. "A Simple Method for Estimating Barotropic Tidal Currents on Continental Margins with Specific Application to the M_2 Tide off the Atlantic and Pacific Coasts of the United States." (See complete entry in Section I.)

Battisti, D. S., and Clarke, A. J. "Estimation of Nearshore Tidal Currents on Non-smooth Continental Shelves." (See complete entry in Section I.)

Benque, J. P., et al. "New Method for Tidal Current Computation." (See complete entry in Section I.)

Bohlen, W. F. 1978. "Factors Governing the Distribution of Dredge-Resuspended Sediments," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:2001-2019.

Field observations are analyzed to determine the primary factors governing the distribution of sediments suspended by clamshell bucket dredge operations. These data show the plumes produced under typical estuarine conditions to be relatively small-scale features having maximum long-stream dimensions of approximately 700 m. Plumes can be considered to consist of three contiguous zones: an initial mixing zone, a secondary zone, and a final mixing zone. The initial mixing zone immediately adjacent to the dredge has dimensions governed by bucket-induced mixing and suspended material concentrations determined by dredge efficiency. Observations indicate that dimensions can be reasonably estimated using wake theory and that efficiencies result in the introduction of 2-4 percent of the sediment mass contained in each bucket load. Resultant concentrations range between 200 and 400 mg/ℓ. Progressing downstream into the secondary mixing zone, concentrations decay rapidly due primarily to gravitational settling. The observed decay rates indicate an average settling velocity of 4.7 cm/sec well in excess of values based on the grain size characteristics of the dredged sediment. The behavior suggests significant particle agglomeration within this area. At the downstream limit of this zone, distributions become essentially exponential in character and remain so through the final mixing zone. In this area concentrations progressively approach the upstream background levels and variations are governed primarily by diffusion. In each of these zones the observed distributions appear amenable to relatively straightforward modeling. References (13 items).

Bohlen, W. F., and Marine Sciences Department, University of Connecticut. "A Comparison Between Dredge Induced Sediment Resuspension and That Produced by Natural Storm Events." (See complete entry in Section II.)

Bowman, M. J., et al. "Shelf Fronts and Tidal Stirring in Greater Cook Strait, New

Zealand." (See complete entry in Section VI.)

Boyden, C. R., Aston, S. R., and Thornton, I. "Tidal and Seasonal Variations of Trace Elements in Two Cornish Estuaries." (See complete entry in Section II.)

Brown, W. D., and Arellano, E. "The Application of a Segmented Tidal Mixing Model to the Great Bay Estuary, N.H." (See complete entry in Section VI.)

Brown, W. S. "A Comparison of Georges Bank, Gulf of Maine and New England Shelf Tidal Dynamics." (See complete entry in Section I.)

Buchak, E. M., and Edinger, J. E. "User Guide for CE-QUAL-ELV2: A Longitudinal-Vertical, Time-Varying Estuarine Water Quality Model." (See complete entry in Section VI.)

Byrne, R. J., Gammisch, R. A., and Thomas, G. R. "Tidal Prism-Inlet Area Relations for Small Tidal Inlets." (See complete entry in Section I.)

Callender, E., and Hammond, D. E. "Nutrient Exchange Across the Sediment-Water Interface in the Potomac River Estuary." (See complete entry in Section II.)

Carton, J. A. "The Variation with Frequency of the Long-Period Tides." (See complete entry in Section I.)

Chelton, D. B., Jr. "Low Frequency Sea Level Variability Along the West Coast of North America." (See complete entry in Section VI.)

Christiansen, H., and Siefert, W. 1978. "Storm Surge Prediction by Combined Wind and Tide Data," _Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany_, ASCE, I:965-985.

The authors suggest a storm tide forecasting method that allows high-water predictions for a coastline 3 to 4 hours in advance with an accuracy of ±30 min in time and ±20 to 30 cm in height. It is based on _actual_ (not on predicted) data, i.e., exact wind velocity and direction data from a reference station and tide data from two gages. The method was developed by analyzing storm surge curves and wind data of those 50 storm tides that occurred since 1965 in the German Bight. Another 50 storm tides back to the year of 1930 were taken into account, though without exact wind data. The method was proved at all storm tides since 1965 and applied with good success to the events during fall and winter 1977/78 for the

coastline off Cuxhaven. Reference (1 item).

Coastal Sediments '77, Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE. (See complete entry in Section II.)

Connell, D. W., et al. "Effects of a Barrage on Flushing and Water Quality in the Fitzroy River Estuary, Queensland." (See complete entry in Section V.)

Crout, R. L., and Murray, S. P. 1978. "Shelf and Coastal Boundary Layer Currents, Miskito Bank of Nicaragua," _Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany_, ASCE, III:2715-2729.

A 2-year study of the currents and salinity (density) fields has been conducted on the broad, shallow Miskito Bank of the eastern coast of Nicaragua. Observations across the bank show a southward-flowing low-salinity, seaward-thinning wedge of highly turbid water trapped against the coast within the first 25-40 km offshore. This so-called coastal boundary layer grades seaward into a northward-flowing shelf current of open-sea salinity that is essentially free of suspended sediment. Detailed transects across the coastal boundary layer show the salinity (density) structure to be closely coupled to the high-speed jet of south-flowing water. Velocity and density measurements from the coastal boundary layer allow quantitative evaluation of each of the terms in the momentum balance equation and of the effect that each has on the circulation dynamics. The Coriolis force, the baroclinic and barotropic pressure gradient forces, and the internal friction force make important contributions to the on-offshore force balance. In the longshore balance, only the baroclinic pressure gradient force was found to be insignificant. A marked difference in this balance of forces was observed in the upper and lower layers of the water column in both the alongshore and on-offshore balances. References (12 items).

Daifuku, P. R., and Beardsley, R. C. 1983. "The K_1 Tide on the Continental Shelf from Nova Scotia to Cape Hatteras," _Journal of Physical Oceanography_, 13(1):3-17.

A description is given of the K_1 tide over the northeast continental shelf off North America from Nova Scotia to Cape Hatteras. Analyzed pressure data obtained from W. Brown and J. Irish (University of New Hampshire) have been used to draw up the K_1 cotidal map and existing current data have been analyzed to give the associated velocity map. Offshore, there is a sweep of the tide from north to south, in general agreement with what is known of

the oceanic K_1 tide in the North Atlan-
tic. On the shelf, there is a trapping of
phase lines to the coast, creating, in
particular, a virtual amphidrome south of
Cape Cod. Maximum amplitudes of around
15 cm are found in the Gulf of Maine, low-
est around 7 cm south of Cape Cod. The
K_1 currents are generally barotropic and
current ellipses are aligned with the
local topography. Maximum currents of
about 10 cm s^{-1} are found south of Cape
Cod. A simple model for the K_1 pressure
field is developed using the free and
forced inviscid barotropic waves on a two-
dimensional shelf. The theoretical solu-
tions are fitted to the K_1 pressure data
using a least-squares method. The model
results confirm that the K_1 tide is com-
posed of both a Kelvin wave and a shelf
wave, with the Kelvin wave dominating the
pressure field, and the shelf wave domi-
nating the current field. The two free
waves account for 99 percent of the vari-
ance of the difference of the observed
pressures and the calculated forced wave,
but unfortunately some of the observed
features are not accurately reproduced.
Possible model improvements should include
the addition of bottom friction and long-
shore topographic variations (especially
the changes in shelf geometry associated
with the Gulf of Maine). References
(20 items).

Dandy, G. C., Mills, D. A., and Hinwood,
J. B. "Water Movement Studies Required
for Port Planning." (See complete entry
in Section I.)

Davesne, M., and Graff, M. "Mathematical
and Physical Models for Navigation in
Approach Channels and Harbour Entrances."
(See complete entry in Section V.)

Dennis, W. A., Lanan, G. A., and Dalrymple,
R. A. "Case Studies of Delaware's Tidal
Inlets: Roosevelt and Indian River
Inlets." (See complete entry in Sec-
tion VI.)

Diamante, J. M., et al. "Tidal and Geodetic
Observations for the SEASAT Altimeter
Calibration Experiment." (See complete
entry in Section VII.)

Drapeau, G., and Fortin, G. "Tidal Sedimen-
tation in Gros-Cacouna Harbor." (See com-
plete entry in Section II.)

Druery, B. M. "Estuarine Response to Dredg-
ing in the Tweed River, Australia." (See
complete entry in Section V.)

Druery, B. M., and Nielsen, A. F. "Mecha-
nisms Operating at a Jettied River En-
trance." (See complete entry in Sec-
tion II.)

Durham, D. L. 1977. "Los Angeles Harbor
and Long Beach Harbor: Analyses of Proto-
type Wave and Ship Motion Data," Ports
'77, 4th Annual Symposium of the Waterway,
Port, Coastal and Ocean Division of ASCE,
Long Beach, Calif., March 9-11, 1977,
I:27-46.

Procedures and results of analyses of pro-
totype ship motion and wave data collected
in Los Angeles and Long Beach Harbors dur-
ing a 13-month data acquisition program
are discussed. Prototype data were re-
quired to identify wave and tidal condi-
tions and mooring problems in the existing
harbors and for use in various physical
and numerical modeling studies of proposed
harbor expansions. Observations of ship
characteristics, movement, and mooring
line configurations were parametrically
studied for various statistical informa-
tion regarding ship mooring and movement.
A numerical analysis of moored ship re-
sponse to wave excitation was conducted to
define the periods or frequency ranges of
maximum surge response for specific ships
and mooring configurations in the East
Channel of Los Angeles Harbor. Estimates
of wave energy for wave periods ranging
from 15 sec to 30 min were calculated by
spectral analyses of prototype wave data.
Time-dependent spectral estimates were
calculated for 10 time histories during
which concurrences of medium and/or heavy
ship movement occurred in the East Chan-
nel. From such spectral techniques,
frequency bands containing significant
energy levels were identified for 13 wave
gage locations in the harbors. In addi-
tion to identifying characteristic fre-
quency bands of wave energy at each gage
and the frequency for maximum wave energy
in each characteristic band, time varia-
tions of energy levels within each fre-
quency band and the distribution of swell
throughout the harbors were estimated.
Observations of significant ship motion in
the East Channel of Los Angeles Harbor
were correlated with time variations of
wave energy in characteristic frequency
bands. Subjective analyses of analog wave
records were conducted to provide indica-
tions of the frequency of occurrence and
wave-height distributions for characteris-
tic harbor oscillations and swell. Refer-
ences (10 items).

Dyer, K. R. "Mixing Caused by Lateral In-
ternal Seiching Within a Partially Mixed
Estuary." (See complete entry in Sec-
tion III.)

Dyer, K. R. "The Mixing Processes in a Par-
tially Mixed Estuary: Southampton Water."
(See complete entry in Section VII.)

Ebbesmeyer, C. C., and Barnes, C. A.
1980. "Control of a Fjord Basin's Dynam-
ics by Tidal Mixing in Embracing Sill

Zones," _Estuarine and Coastal Marine Science_, 11(3):311-330.

A common configuration in fjords is a basin embraced by sills. This paper addresses the dynamics of a large fjord basin lying between comparatively deep sills where tidal mixing is vigorous: Puget Sound's Main Basin (~10 km × 90 km × 0.3 km) between 44 m (landward) and 66 m (seaward) depth sills. Tidal action over the sills causes a vigorous two-layer circulation in the basin where no net motion occurs near the average depth of the embracing sills. On the flood tide lower-layer water is upwelled at the landward sill and upper-layer water is downwelled at the seaward sill. The resultant circulation in the basin is quite active at all depths throughout the year. Currents computed from differences in dissolved oxygen between hydrographic stations compare favorably with measured currents. Based on differences between the ends of the basin, the bulk residence time in the lower layer is about 3 weeks--a short time for a large fjord basin. Experiments in a hydraulic model demonstrate the marked sensitivity of basin circulation to tidal action in the sill zones: transport in the upper layer is directly proportional to the tidal prism inland of the landward sill zone, and there is an exponential type of response to abrupt changes in fresh water flowing into the seaward sill zone (approximately 60 percent of equilibrium attained in 2 months). The rapid response causes the basin's lower-layer water properties to follow closely both the primary and secondary features of the seasonal cycles of local air temperature and runoff. References (35 items).

Egan, J. T., and Jones, H. L. "Tidal Measurement, Analysis, and Prediction." (See complete entry in Section VII.)

Elliott, A. J. "Observations of the Meteorologically Induced Circulation in the Potomac Estuary." (See complete entry in Section I.)

Elsinger, R. J., and Moore, W. D. "^{226}Ra and ^{228}Ra in the Mixing Zones of the Pee Dee River-Winyah Bay, Yangtze River and Delaware Bay Estuaries." (See complete entry in Section IV.)

Escoffier, F. F. "Hydraulics and Stability of Tidal Inlets." (See complete entry in Section I.)

Essen, H.-H., Gurgel, K.-W., and Schirmer, F. "Tidal and Wind-Driven Parts of Surface Currents, as Measured by Radar." (See complete entry in Section I.)

Evans, J. J., and Pugh, D. T. "Analysing Clipped Sea-Level Records for Harmonic Tidal Constituents." (See complete entry in Section I.)

Fandry, C. B. "Development of a Numerical Model of Tidal and Wind-Driven Circulation in Bass Strait." (See complete entry in Section VI.)

Filloux, J. H., and Snyder, R. L. 1979. "A Study of Tides, Setup and Bottom Friction in a Shallow Semi-Enclosed Basin; Part I: Field Experiment and Harmonic Analysis," _Journal of Physical Oceanography_, 9(1):158-169.

The paper describes three month-long field experiments in the Bight of Abaco, Bahamas, employing 15 tide gages and four weather stations distributed throughout the bight. The amplitude and phase of five principal tidal constituents and the M4 and M6 overtides are estimated for all stations and errors computed from a generalization/hybridization of the algorithm of Munk and Hasselman for tidal doublets. The resulting tidal distributions constitute an unusually complete data base against which to optimize the numerical models reported in Parts II and III of the series. The relatively small amplitude of the overtide constituents are locally generated. Residual fluctuations are highly coherent with the wind field. Significant differential setup effects are apparent. References (6 items).

Fornerino, M., and Chabert d'Hieres, G. "Study of M_2 Tidal-Currents in the English Channel Using the Physical Model at Grenoble." (See complete entry in Section VI.)

Franco, A. d. S. "On the Shallow-Water Harmonic Tidal Constituents." (See complete entry in Section I.)

Freeland, H. J. "Tidal Analysis and the Energy Budget of a Deep Stratified Inlet." (See complete entry in Section I.)

Funke, E. R., and Crookshank, N. L. "A Hybrid Model of the St. Lawrence River Estuary." (See complete entry in Section VI.)

Garofalo, D. "The Influence of Wetland Vegetation on Tidal Stream Channel Migration and Morphology." (See complete entry in Section III.)

George, K. J. "Application of the Species Concordance Method to the Tidal Currents in the Loire." (See complete entry in Section I.)

George, K. J., and Simon, B. "The Species Concordance Method of Tide Prediction in Estuaries." (See complete entry in Section I.)

Gibbs, R. J. "Currents on the Shelf of North-eastern South America." (See complete entry in Section I.)

Glen, N. C. "The Tidal Survey of the British Isles." (See complete entry in Section VII.)

Göhren, H., and Christiansen, H. "Ecological Aspects of a Deep Water Port in the Tidal Flats off the German Coast (Scharhörn)." (See complete entry in Section V.)

Gopalakrishnan, T. C., and Machemehl, J. L. "Boundary Conditions for Analysis of Flow in Tidal Inlets." (See complete entry in Section I.)

Grabemann, I., Krause, G., and Siedler, G. "Long-Time Changes of Salinity in the Lower Weser." (See complete entry in Section III.)

Graff, J., and Karunaratne, A. "Accurate Reduction of Sea Level Records." (See complete entry in Section VII.)

Graham, D. S., Hill, J. M., and Christensen, B. A. "Verification of Estuarine Model for Apalachicola Bay, Florida." (See complete entry in Section VI.)

Granat, M. A., and Gulbrandsen, L. F. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)

Harleman, D. R. F. "Diffusion and Dispersion Processes." (See complete entry in Section VI.)

Hartnoll, R. G., and Hawkins, S. J. 1982. "The Emersion Curve in Semidiurnal Tidal Regimes," Estuarine, Coastal and Shelf Science, 15(4):365-371.

Emersion curves are presented for eight locations in Britain experiencing semidiurnal tides. Curves were produced by computer analysis of reduced hourly tide gage observations over a one-year period, and were not based upon predicted times of high water and low water as mostly used hitherto. The locations differ in tidal constants and the form of the tide curve. The shape of the emersion curve varies markedly between locations, and for each curve the slope, which indicates the rate of change of environmental conditions, is analyzed with respect to height at the tide gage. Critical tide levels, where conditions change particularly rapidly, are obvious on some curves but less evident on others. References (10 items).

Haury, L. R., et al. 1983. "Tidally Generated High-Frequency Internal Wave Packets and Their Effects on Plankton in Massachusetts Bay," Journal of Marine Research, 41(1):65-112.

Tidally generated internal wave packets occur twice a day during late summer in Massachusetts bay, U.S.A. The packets are formed at Stellwagen Bank and propagate into the bay at about 60 cm sec^{-1}; they dissipate in shallow water at the western side of the bay. The dominant waves in packets have lengths of about 300 m, periods of between 8 and 10 min, and amplitudes of up to 30 m. Overturning of the waves has been observed acoustically over Stellwagen Bank, in the deep (80 m) waters in the center of the bay, and during dissipation in shallow water. The effects of the internal waves on the distribution of plankton were investigated in August 1977 using an instrument package (Longhurst-Hardy Plankton Recorder, in situ fluorometer, conductivity, temperature, depth (CTD)) towed either at a constant depth or following an isotherm through wave packets. Phytoplankton and zooplankton appear to be carried passively up and down by the internal waves; the data were insufficient to resolve any active response by zooplankton to vertical displacements by the waves. Vertical distributions of the plankton were altered by overturning of waves and subsequent mixing. Patterns of horizontal distributions of plankton determined by constant-depth tows were dominated by the effects of internal wave vertical displacements. Isotherm-following tows removed much of the variability due to wave displacement, but problems of following rapidly moving isotherms introduced considerable smaller-scale variability. Changes in zooplankton abundance on tow length scales (600-1200 m) were not correlated with temperature, salinity, or density; some significant correlations with chlorophyll fluorescence occurred when internal wave activity was present. Twice a day for several hours or more, phytoplankton were vertically displaced by as much as 30 m, with a period of about 10 min. The light level plant cells experienced varied from 0.1 to 26 percent of the ambient surface illumination. This rapid change in light should alter fluorescence yields of plant cells and affect continuous in situ measurements of chlorophyll fluorescence. The timing of internal wave packets varies with the semidiurnal tidal cycle and therefore interacts with the day-night cycle to significantly alter the light regime experienced by plant cells over a 2-week period. This could affect the primary productivity of the bay in the area affected by internal wave packets. The sporadic occurrence of internal wave overturning and mixing events in the deep waters of the bay could enhance primary production by increasing nutrient input to

the mixed layer. This effect should be greatly enhanced in the shallow waters where the internal waves dissipate. Comparison of acoustic and plankton recorder data showed that much of the intense acoustic backscattering seen in high-amplitude (10-20 m) internal waves is due to physical structure and processes, and not to the presence of zooplankton. References (60 items).

Hawley, N. "Intertidal Sedimentary Structures on Macrotidal Beaches." (See complete entry in Section I.)

Hayes, M. O., Kana, T. W., and Barwis, J. H. 1980. "Soft Designs for Coastal Protection at Seabrook Island, S.C.," *Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia*, ASCE, I:897-912.

To gain a better understanding of the cycles of shoreline changes on Seabrook Island, South Carolina, and advise a private developer on how to deal with localized erosion problems, a detailed field survey and historical study were completed. The data base included historical charts dating from 1661, vertical aerial photographs from 1939, field surveys of beach profiles and nearshore bathymetry over a 6-month period, and sediment cores through the entire Holocene section. Seabrook Island, less than 6 km in length, is bounded by tidal inlets with extensive seaward shoals. With a 2-m tidal range for the area, changing exposure and orientation of the shoals over time have had a profound effect on the adjacent shoreline of Seabrook Island. Historical evidence points to the importance of offshore shoals which act as natural breakwaters and sediment storage systems. At various times in recent history, these shoals have supplied sediment to Seabrook beaches by means of bypassing mechanisms around tidal inlets. On the other hand, migration of shoals has allowed excess wave energy to strike portions of the shore causing local erosion. Along a portion of the shoreline, short-term erosion is jeopardizing the development. Based on the present study, a set of "soft" engineering designs was proposed which attempt to manipulate offshore sand bodies in a way that will be beneficial to the development and preserve the inherent beauty of the shoreline. Remedial measures recommended for the developer included dredging new inlet channels and construction of a breakwater in the position of a former protective shoal. References (7 items).

Hayter, E. J., and Mehta, A. J. "Verification of Changes in Flow Regime Due to Dike Breakthrough Closure." (See complete entry in Section VI.)

Heaps, N. S. "Three-Dimensional Modelling of the Irish Sea." (See complete entry in Section VI.)

Heaps, N. S., and Jones, J. E. "Recent Storm Surges in the Irish Sea." (See complete entry in Section VI.)

Heathershaw, A. D., Carr, A. P., and Blackley, M. W. L. "Swansea Bay (SKER) Project, Topic Report 8; Coastal Erosion and Nearshore Sedimentation Processes." (See complete entry in Section II.)

Heathershaw, A. D., and Hammond, F. D. C. "Swansea Bay (SKER) Project, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations and Their Response to Meteorological Conditions." (See complete entry in Section I.)

Heathershaw, A. D., and Hammond, F. D. C. "Swansea Bay (SKER) Project, Topic Report 6; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data." (See complete entry in Section II.)

Heathershaw, A. D., and Lees, B. J. "Sizewell-Dunwich .anks Field Study, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations." (See complete entry in Section I.)

Helwick, S. J., and Bryant, W. R. "Geology and Geotechnical Characteristics of Sediments in East Bay Area, Mississippi Delta." (See complete entry in Section II.)

Hickel, W. "The Influence of Elbe River Water on the Wadden Sea of Sylt (German Bight, North Sea)." (See complete entry in Section III.)

Higgs, K., Treloar, P. D., and Lawson, N. V. "Comparison of Results from Physical and Mathematical Tidal Flow Models with Prototype Data in Botany Bay." (See complete entry in Section V.)

Hinrichs, H. "Coastal and Catastrophe Protection in the Area of the German Bay." (See complete entry in Section V.)

Hinwood, J. B. "Large Scale Turbulence in Tidal Currents." (See complete entry in Section I.)

Hinwood, J. B., and Colman, R. S. "Use of an Echo Sounder to Map Vertical Stratification in an Estuary." (See complete entry in Section VII.)

Hodgson, R. T., Pettibone, B., and Sullivan, S. M. "Siltation Study of Humboldt Bay Marina, California." (See complete entry in Section II.)

Holloway, P. E. 1983. "Internal Tides on the Australian North-West Shelf: A Preliminary Investigation," Journal of Physical Oceanography, 13(8):1357-1370.

An analysis of current meter data and cross-shelf temperature measurements from the Australian North-West Shelf shows the existence of internal waves of semidiurnal period. Vertical displacements of density interfaces are seen to reach ~30 m, a value nearly half the water depth. Baroclinic currents are isolated from the measurements and have amplitudes reaching 0.2 m sec^{-1} in the cross-shelf direction. The baroclinic motion is shown to be consistent with a first-mode internal wave propagating in the onshore direction at phase speed of approximately 0.4 m sec^{-1} with wavelength of 20 km and being rapidly damped in amplitude while propagating across the shelf. The dissipation of the internal tide across the shelf appears to result from the influence of turbulent mixing processes. There is little coherence between the barotropic tide and the internal tide, and it is suggested that this results from the internal tide being generated over a large section of the shelf slope down to a depth of approximately 900 m. There is no obvious point source of generation for the internal tide. References (8 items).

Holloway, P. E. 1983. "Tides on the Australian North-West Shelf," Australian Journal of Marine and Freshwater Research, 34(1):213-230.

Harmonic analysis of the records from 14 current meters and 3 offshore tide gages from the Australian north-west shelf and continental slope regions and a number of coastal stations shows that tidal motion is dominated by the principal lunar (M_2) and principal solar (S_2) constituents. The tidal velocities are essentially barotropic with flow predominantly in the cross-shelf direction at the shelf break changing to predominantly along-shelf near the coast. The elevations of the M_2 and S_2 constituents are amplified across the shelf off Dampier by 1.3 times and by approximately 5 times along the length of the shelf, a distance of around 1,000 km. Several features of the semidiurnal shelf tide are discussed with the aid of a simple analytical model. The cross-shelf bathymetry is shown to produce cross-shelf amplification of the semidiurnal tide in good agreement with the observations off Dampier. An along-shelf pressure gradient results from the change in elevation of the tide along the coast and this pressure gradient is shown to be the main driving mechanism of the along-shelf component of the M_2 and S_2 velocities. The gradient also influences, but to a lesser extent, the cross-shelf component of the velocity and the cross-shelf amplification of the

semidiurnal tidal elevation. Results of a world ocean tidal model are presented and indicate the existence of a gradient in the shelf-edge M_2 tide along the shelf, and this is shown to have an important effect on the shelf tide. References (7 items).

Hopkins, T. S., Salusti, E., and Settimi, D. 1984. "Tidal Forcing of the Water Mass Interface in the Strait of Messina," Journal of Geophysical Research, 89(C2):2013-2024.

The tidal currents of the Strait of Messina and their effect on the displacement of the water-mass interface are discussed utilizing the historical velocity data of Francesco Vercelli, taken from ~100 anchor stations during 1922 and 1923. The data show a complex, strongly tidal behavior, in which speeds of 200-300 cm/s are attained over the sill. Messina is an amphidromic point for the tides of the two main basins of the Mediterranean Sea, and two distinct water masses flow through the strait at different stages of the tide: the subsurface Levantine intermediate water flowing north alternating with surface Tyrrhenian water flowing south. The time evolution of the interface between the two marine water layers at the semidiurnal periodicity is computed from the observed distribution of acceleration term for the baroclinic component. This interface shows large vertical oscillations with amplitudes of ~100 m intersecting both the surface and bottom. The results are in reasonable agreement with recent satellite data and other recent field observations and numerical experiments. An estimate of the mean position of the interface is made by assuming that the potential energy required to uplift the interface, from the equilibrium depth of 150 m to the observed 30-m depth over the sill, is derived from the time-independent contribution of the nonlinear field acceleration term. The results are in reasonable agreement with observations. Reference: (24 items).

Howarth, M. J., and Huthnance, J. M. 1984. "Tidal and Residual Currents Around a Norfolk Sandbank," Estuarine, Coastal and Shelf Science, 19(1):105-117.

Currents on either side of Well Bank were recorded for 41 days in May-June 1981, in order to distinguish locally tidally generated asymmetries (pertinent to maintenance of the bank) from larger scale and wind-driven flows. Semidiurnal currents were dominant, nearly rectilinear, and slightly inclined to the bank axis. Fourth-diurnal currents were consistent with previously observed and computed fourth-diurnal tides for the area overall; amplitudes varied as the square of the semidiurnal amplitude. Hence they appear

to be generated by tides, but only a small part locally. Residual currents (average over a tidal cycle) were always in the sense of clockwise circulation around the bank, consistent with simple models and giving strong evidence of local generation by tides. This circulation combines with the semidiurnal currents to maintain the bank. The slow increase of the residuals with the semidiurnal amplitude is interpreted as an effect of strong semidiurnal currents. A persistent component onto the bank 7 m above the bottom at one position may indicate distortion of the frictional layer by the sloping bottom or by bank curvature. References (19 items).

Hsueh, S. F., and Ahlert, R. C. "Mixing in Shallow Coastal Sea: Case Study." (See complete entry in Section VI.)

Hunkins, K. "Salt Dispersion in the Hudson Estuary." (See complete entry in Section III.)

Huntley, D. A., and Nummedal, D. "Velocity and Stress Measurements in a Tidal Inlet." (See complete entry in Section VII.)

Hutchison, I. P. G., and Midgley, D. C. "Mathematical Modelling of Water Level and Salinity Regimes in Some South African Lake and Estuary Systems." (See complete entry in Section VI.)

Jain, S. C. "Movable-Bed Tidal Inlet Model." (See complete entry in Section VI.)

Jenkins, S. A., Inman, D. L., and Bailard, J. A. "Opening and Maintaining Tidal Lagoons & Estuaries." (See complete entry in Section VI.)

Jiang, J. X., and Falconer, R. A. "On the Tidal Exchange Characteristics of Model Rectangular Harbours." (See complete entry in Section VI.)

Jones, I. S. F., and Padman, L. "Semidiurnal Internal Tides in Eastern Bass Strait." (See complete entry in Section I.)

†Karthegisan, J., and Thomas, M. P. "The Effect of Tidal Heights on the Distribution and Abundance of Coliform Bacteria in the Sediments of Two Sites in the Mersey Estuary." (See complete entry in Section IV.)

Karunartne, D. A. "An Improved Method for Smoothing and Interpolating Sea Level Data." (See complete entry in Section I.)

Kato, M. "Observation of Crustal Movements by Newly-Designed Horizontal Pendulum and Water-Tube Tiltmeters with Electromagnetic Transducers (2)--Variations in the

Amplitude and Phase of Tidal Tilts Observed with a Water-Tube Tiltmeter at Kamitakara." (See complete entry in Section I.)

Kelley, J. T. "Composition and Origin of the Inorganic Fraction of Southern New Jersey Coastal Mud Deposits." (See complete entry in Section II.)

Khorram, S. "Remote Sensing of Salinity in the San Francisco Bay Delta." (See complete entry in Section VII.)

King, h. L., Scott, M. A., and Smith, T. J. 1983. "Some Remarks on the Analysis of Short Tidal Records," Deutsche Hydrographische Zeitschrift, 36(2):45-59.

The errors inherent in the harmonic analysis of short tidal records have been investigated using synthetic elevation and real velocity records. The sources of error were identified as the presence of noise, tidal constituents not included in the analysis, and the duration of the record. Of these sources, the record duration was shown to be the greatest contributor to the total error. By analyzing a synthetic tidal record, an empirical estimate of the variation of the error in the M_2 component with record length is obtained. This is then shown to predict the errors in the analysis of an actual velocity record. A method is also presented for separating the M_2 and S_2 constituents in records of 36 hours' duration or less. References (6 items).

Kirby, R., and Parker, W. R. "A Suspended Sediment Front in the Severn Estuary." (See complete entry in Section II.)

Knebel, H. J., et al. "Sedimentary Framework of the Potomac River Estuary, Maryland." (See complete entry in Section II.)

Knight, D. W. 1981. "Some Field Measurements Concerned with the Behaviour of Resistance Coefficients in a Tidal Channel," Estuarine, Coastal and Shelf Science, 12(3):303-322.

Measurements of the individual terms in the one-dimensional unsteady flow momentum equation in a 1.2-km tidal reach of the Conwy estuary, North Wales, have yielded values for the resistance coefficients commonly adopted in open channel flow hydraulics. The results indicate clearly that Manning's n or Darcy-Weisbach's f varies significantly with stage, and to a lesser extent with flow direction. The relative importance of the various terms in the one-dimensional momentum equation are illustrated, and the techniques employed in measuring them indicated. Values of Nikuradse's roughness parameter, k_s, have also been computed and are shown

to vary significantly with water level. Mean bed shear stresses have been evaluated, and the variation in bed shear velocity throughout different tidal cycles determined. The results indicate the inadvisability of selecting a single roughness parameter to represent the hydraulic characteristics of any individual element in a numerical tidal model. References (20 items).

Knowles, C. E. "Estimation of Surface Gravity Waves from Subsurface Pressure Records for Estuarine Basins." (See complete entry in Section VII.)

Knowles, C. E. 1981. "Wind-Wave Climatology and Wind-Tides for Fort Raleigh Wave-Gauge Site, 1979," Working Paper 81-8, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh.

The wave data presented and discussed were recorded almost continuously from January 26 to December 31, 1979, by a pressure transducer mounted 30 cm above the bottom offshore immediately adjacent to the Fort Raleigh National Historic Site. The data were collected as part of a shoreline stabilization project. The monthly wave climatologies and wind tides at the Fort Raleigh site for 1979 are given. References (9 items).

Kowalik, Z. and Matthews, J. B. 1982. "The M_2 Tide in the Beaufort and Chukchi Seas," Journal of Physical Oceanography, 12(7):743-746.

The amplitude and phase of the M_2 tide for the Beaufort and Chukchi seas were derived from the vertically integrated equations of motion and continuity. The boundary conditions at the open boundaries were taken both from previous numerical models and observations. The results are shown as cotidal and corange lines and a distribution of current ellipses. The results are compared with the few available measurements. Cotidal and corange lines support the existence of amphidromes at the entrance to the Amundsen Gulf and in the Chukchi Sea. The former amphidrome has been confirmed by Canadian observers. It is believed that the latter amphidrome is reported for the first time. References (11 items).

Kranck, K. 1980. "Variability of Particulate Matter in a Small Coastal Inlet," Canadian Journal of Fisheries and Aquatic Sciences, 37(8):1209-1215.

Total suspended particulate matter concentration and grain size spectra, total and living particulate carbon, and dissolved nitrogen and carbon were measured at stations along the length of Petpeswick Inlet and over several tidal cycles. Distinct particle populations were associated with the water at the head and at the mouth of the inlet. Mixing of water masses and temporal periodicities cause variances in particle concentration and spectral shape which correspond to seasonal, tidal, and seiche variations. To explain the last, a process of transformation of organic matter between dissolved and particulate states by aggregate formation and breakup in response to turbulent changes is proposed.

Lake, C. A., and MacIntyre, W. G. "Phosphate and Tripolyphosphate Adsorption by Clay Minerals and Estuarine Sediments." (See complete entry in Section II.)

Lara-Lara, J. R., Alvarez-Borrego, S., and Small, L. F. "Variability and Tidal Exchange of Ecological Properties in a Coastal Lagoon." (See complete entry in Section I.)

Lee, G. F. "Persistence of Chlorine in Cooling Water from Electric Generating Station." (See complete entry in Section IV.)

Leenknecht, D. A., Earickson, J. A., and Butler, H. L. "Numerical Simulation of Oregon Inlet Control Structures' Effects on Storm and Tide Elevations in Pamlico Sound." (See complete entry in Section VI.)

Lees, B. J. 1983. "Observations of Tidal and Residual Currents in the Sizewell-Dunwich Area, East Anglia, U.K.," Deutsche Hydrographische Zeitschrift, 36(1):1-24.

Current meter data from the shallow nearshore Sizewell-Dunwich area, off the coast of East Anglia, U.K., have been harmonically analyzed, enabling the tidal and residual currents of the region to be described. The area is close to the amphidrome in the southern part of the North Sea, and this dominates the tidal current pattern. Thus the astronomical tides are mixtures of standing and progressive waves and for M_2 are in the proportion 3:2. The tidal currents are nearly rectilinear, flowing parallel to the coast with maximum midwater velocities up to 1.20 m s^{-1}. Estimations have been made of the tidal energy flux through the area and of the frictional dissipation at the seabed, showing that energy fluxes are weaker inshore. The residual circulation is complex although there is evidence of an anticlockwise eddy over the seaward flank of the Sizewell Bank. References (29 items).

Lees, B. J., and Heathershaw, A. D. "Sizewell-Dunwich Banks Field Study, Topic Report 5; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data." (See complete entry in Section II.)

Le Fèvre, J., et al. 1983. "Remote Sensing
   Observations of Biological Material by
   LANDSAT along a Tidal Thermal Front and
   Their Relevancy to the Available Field
   Data," Estuarine, Coastal and Shelf Sci-
   ence, 16(1):37-50.

Two images recorded on two successive
summer days by LANDSAT satellite over the
western approaches to the English Channel
show bright pattern of complex shape the
origin of which is puzzling. Among the
wavelength bands available on LANDSAT's
multispectral scanner, these patterns are
apparent only in the green region of the
spectrum, and they are located toward the
stratified side of a well-marked tidal
thermal front. Spectral signature analy-
sis and available knowledge on hydrography
and plankton in the area are used to
derive a proposed interpretation. Phyto-
plankton would accordingly be the best
candidate for being responsible for the
observed patterns. References (51 items).

Leitass, R. "Wave Damages to Stone Slope
   Under Marginal Wharves." (See complete
   entry in Section VI.)

Lentsch, J. W., et al. "Stable Manganese
   and Manganese-54 Distributions in the
   Physical and Biological Components of the
   Hudson River Estuary." (See complete
   entry in Section IV.)

Le Provost, C., and Poncet, A. "Finite
   Element Method for Spectral Modelling of
   Tides." (See complete entry in Sec-
   tion I.)

Lewis, R. E., and Lewis, J. O. "The Princi-
   pal Factors Contributing to the Flux of
   Salt in a Narrow, Partially Stratified
   Estuary." (See complete entry in Sec-
   tion III.)

Liou, Y.-C., and Herbich, J. B. "Velocity
   Distribution and Sediment Motion Induced
   by Ship's Propeller in Ship Channels."
   (See complete entry in Section II.)

Liu, S. K., Hou, H. S., and Chang, C. C.
   "Simulation of Wave/Wind Forced Harbor Os-
   cillation." (See complete entry in Sec-
   tion VI.)

Ludwick, J. C. 1977. "Jet-Like Coastal
   Currents and Bottom Sediment Transport off
   Virginia Beach, Virginia," Hydraulic Sen-
   sor Instrumentation of a Shore Face in a
   Tidal Current Convergence Zone--Cape
   Henry, Virginia, Technical Report No. 25,
   Institute of Oceanography, Old Dominion
   University, Norfolk, Virginia, Part II:1-
   60.

Synoptic data on near-surface and near-
bottom currents for two 1-month periods
are analyzed for six stations located in
the coastal boundary zone 3.5 to 7 km
offshore in water depths from 8.2 to
23.8 m. Data were taken with savonius
rotor devices and represent 15-minute time
averages of speed and direction. High-
frequency noise was removed with a numeri-
cal smoothing filter. Tidal currents,
separated out by harmonic analysis, are
rotary with long ellipse axes approxi-
mately parallel to the shoreline and are
nearly synchronous. Principal tidal con-
stituents are M_2, S_2, N_2, K_1, O_1, J_1,
and SO_1. Maximum tidal current speed de-
creases with distance to the south away
from the entrance to Chesapeake Bay. Near
the surface, tidal current speeds at
spring strength decrease progressively
from 52.3 cm/sec in the entrance area to
Chesapeake Bay to 18.5 cm/sec at a point
22 km to the south. Near the bottom cor-
responding tidal currents decrease from
32.4 cm/sec in the entrance to 8.2 cm/sec
at the southernmost location. Near-bottom
tidal currents are incapable by themselves
of moving fine sand. Forty-hour low-
passed currents are wind- and slope-
driven, but reach peak speeds near the
surface of 48 cm/sec in events of up to
6 days' duration. In summer a strong
pycnocline inhibits downward propagation
of these high-speed surface currents. In
the fall, southward-directed high-speed
coastal jets penetrate readily to the bot-
tom. Response time of the surface waters
to wind events is less than 3 hours.
South-directed winds in summer generate
stronger currents than north-directed
winds of the same speed. Spatial acceler-
ations and seasonal variations in wind
regimes and corresponding currents seem to
require a strong south slope to the sea
surface in summer and a very gentle slope
to the north in the fall. These slopes
may be related to seasonal changes in
efflux from the bay entrance. Between
strong aperiodic wind events, a weak estu-
arine circulation exists. Waves entrain
the bed sediment 60 to 83 percent of the
time in depths of 8 to 13 m. With a cor-
responding lowered threshold taken at
20 cm/sec, only the south-directed low-
pass currents supplement the incompetent
tidal currents so as to produce sediment
transport. Threshold exceedance in 8 to
13 m occurs 5 to 12 percent of the time
under south-directed low-pass currents in
summer and 19 to 28 percent of the time
under south-directed low-pass currents in
the fall. At 15 m, the transport thresh-
old was not reached during the observation
period. A coastwise parallel belt of fre-
quent but intermittent bed sediment trans-
port is thus defined. The frequency of
exceedance decreases to the south away
from the entrance area. From the sediment
transport continuity relationship, it is
reasoned that deposition occurs and at a
decreasing rate with distance to the south
away from the entrance to Chesapeake Bay,
thus matching the seaward bulging

configuration of isobaths east of Cape Henry. If a null should be reached with increasing distance to the south, a depocenter would occur at that point. References (31 items).

Ludwick, J. C., and Johnson, P. B. "Hydraulic Sensor Instrumentation in a Shore Face in a Tidal-Nontidal Coastal Convergence Zone, Cape Henry, Virginia." (See complete entry in Section VII.)

McAnally, W. H., Jr. "Los Angeles Harbor and Long Beach Harbor: Physical Model of San Pedro Bay Tidal Circulation." (See complete entry in Section VI.)

McAnally, W. H., Jr., Brogdon, N. J., Jr., and Stewart, J. P. "Columbia River Estuary Hybrid Model Studies; Report 4, Entrance Channel Tests." (See complete entry in Section VI.)

McAnally, W. H., Jr., and Raney, D. C. "Los Angeles Harbor and Long Beach Harbor: Physical and Numerical Tidal Models: A Comparison." (See complete entry in Section VI.)

McAnally, W. H., Jr., et al. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth." (See complete entry in Section VI.)

MacArthur, R. C. "Turbulent Mixing Processes in a Partially Mixed Estuary." (See complete entry in Section I.)

MacAyeal, D. R. "Numerical Simulations of the Ross Sea Tides." (See complete entry in Section VI.)

McCave, I. N., and Geiser, A. C. 1979. "Megaripples, Ridges and Runnels on Intertidal Flats of the Wash, England," *Sedimentology*, 26(3):353-369.

Observations have been made of parts of the channels and the outer portions of the sand banks in the Wash using 1:10,000 air photographs and brief ground surveys at low spring tides. Two principal structures are found. In the channels, megaripples 0.3-0.6 m high and of 10- to 15-m modal spacing are dominantly flood orientated: they do not reverse during ebb tide. On the outer parts of banks, low ridges of 0.5-m height and 50- to 100-m spacing are interpreted as wave-formed ridge and runnel structure. They contain wave-rippled mud patches in the runnels and although they have shorewards asymmetry do not appear to migrate to any great extent. It is suggested that only in sheltered areas do the Wash intertidal flats show a lower mudflat subfacies; the norm is outer bank sand flats with ridge and runnel structure eventually overlain by Arenicola sand flats during progradation. References (28 items).

McClimans, T. A., and Gjerp, S. A. "Numerical Study of Distortion in a Froude Model." (See complete entry in Section VI.)

Macdonald, G. J., and Weisman, R. N. "Oxygen-Sag in a Tidal River." (See complete entry in Section IV.)

Machemehl, J. L., and Gopalakrishnan, T. C. "Comparison of Numerical Simulation Flow Models for Coastal Inlets." (See complete entry in Section VI.)

Macpherson, J. M. "Response to Urbanization of the Avon-Heathcote Estuary, Christchurch, New Zealand." (See complete entry in Section II.)

Magnell, B. A., et al. "The Relationship of Tidal and Low-Frequency Currents on the North Slope of Georges Bank." (See complete entry in Section I.)

Marche, C., et al. "A Study of the Influence of River Discharge Regulation on the Salinity Equilibrium in the Estuary." (See complete entry in Section III.)

Markofsky, M. "Design of a Tunnel Discharge in an Estuary--Physical Model and Field Studies." (See complete entry in Section VI.)

Martin, J.-M., and Salvadori, F. "Fluoride Pollution in French Rivers and Estuaries." (See complete entry in Section IV.)

Maza, J. A., Munoz, M. L., and Porraz, M. "Jetties Studies Contribution." (See complete entry in Section V.)

Milford, S. N., and Church, J. A. "Simplified Circulation and Mixing Models of Moreton Bay, Queensland." (See complete entry in Section VI.)

Muir, L. R. "Internal Tides in a Partially-Mixed Estuary." (See complete entry in Section I.)

Murty, T. S., and Henry, R. F. 1983. "Tides in the Bay of Bengal," *Journal of Geophysical Research*, 88(C10):6069-6076.

The amplitudes and phases of the tidal constituents M_2, S_2, K_1, and O_1 in the Bay of Bengal are deduced from tide gage records at 112 locations with the aid of numerical models based on the vertically integrated equations of motion and continuity. Tidal elevations along the southern open boundary of the bay were obtained by interpolation from observations. The results are presented in the form of cotidal charts. These show that

the constituents examined have no amphidromic points in the Bay of Bengal apart from a degenerate amphidrome for M_2 in the northwest part of the bay. References (8 items).

Najarian, T. O., et al. "Application of Nitrogen-Cycle Model to Manasquan Estuary." (See complete entry in Section VI.)

National Oceanic and Atmospheric Administration. "Tidal Current Tables" (issued yearly), National Ocean Survey, US Department of Commerce, Rockville, Md.

Current tables for the use of mariners have been published by the National Ocean Service (formerly the Coast and Geodetic Survey) since 1890. Tables for the Pacific coast first appeared in 1898 as a part of the tide tables and consisted of brief directions for obtaining the times of slack water for a few locations from the times of high and low waters. Daily predictions of slack water for two stations were given for the year 1899, and by 1923 the tables had so expanded that they were then issued as a separate publication entitled Current Tables, Pacific Coast. A companion volume, Current Tables, Atlantic Coast, was also issued that year. In 1926 predictions were extended to include the times and velocities of maximum current. Daily predicted times of slack water and predicted times and velocities of maximum current (flood and ebb) are presented for a number of reference stations. Similar predictions for many other locations may be obtained by applying the correction factors to the predictions of the appropriate reference station. The velocity of a current at times between slack water and maximum current may be approximated. The duration of weak current near the time of slack water may be computed.

National Oceanic and Atmospheric Administration. "Tide Tables, High and Low Water Predictions" (issued yearly), National Ocean Survey, US Department of Commerce, Rockville, Md.

Tide tables for the use of mariners have been published by the National Ocean Service (formerly the Coast and Geodetic Survey) since 1853. For a number of years these tables appeared as appendixes to the annual reports of the Superintendent of the Survey, and consisted of more or less elaborated means for enabling the mariner to make his own prediction of tides as occasion arose. The first tables to give predictions for each day were those for the year 1867. They gave the times and heights of high waters only and were published in two separate parts, one for the Atlantic coast and the other for the Pacific coast of the United States. Together they contained daily predictions for 19 stations and tidal differences for

124 stations. A few years later, predictions for the low waters were also included, and for the year 1896 the tables were extended to include the entire maritime world, with full predictions for 70 ports and tidal differences for about 3,000 stations. The tidal tables are now issued in four volumes, as follows: Europe and West Coast of Africa (including the Mediterranean Sea); East Coast of North and South America (including Greenland); West Coast of North and South America (including the Hawaiian Islands); Central and Western Pacific Ocean and Indian Ocean. Together, they contain daily predictions for 198 reference ports and differences and other constants for about 6,000 stations. The following items are included: a table to obtain the approximate height of the tide at any time, a table of local mean time of sunrise for every fifth day of the year for different latitudes, a table for the reduction of local mean time to standard time, a table for converting feet of the moon's phases, apogee, perigee, greatest north and south and zero declination, the time of the solar equinoxes and solstices, and a glossary of terms. Up to and including the tide tables for the year 1884, all the tide predictions were computed by means of auxiliary tables and curves constructed from the results of tide observations at the different ports. From 1885 to 1911, inclusive, the predictions were generally made by means of the Ferrel tide-predicting machine. From 1912 to 1965, inclusive, they were made by means of the Coast and Geodetic Survey tide-predicting machine No. 2. Since 1966, predictions have been made by electronic computer.

Nece, R. E., and Scheffner, N. W. 1978. "Field Data Analysis for Chesapeake Bay Model Verification," Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2870-2886.

Currents and salinities in the generally shallow, partially mixed estuary are strongly influenced by winds in addition to tides and to time-variable freshwater inflows from the drainage basin of approximately 166,000 sq km. The large size of the actual estuary ruled out the possibility of obtaining synoptic prototype data of sufficiently fine-grained detail against which to verify the recently constructed Chesapeake Bay model. This paper presents the procedures used in an initial treatment of the prototype data. References (8 items).

Nece, R. E., and Smith, H. N. "Tidal Exchange in Proposed Sitka, Japonski Lagoon, Small Boat Harbor." (See complete entry in Section VI.)

Nece, R. E., et al. "Effects of Planform
Geometry on Tidal Flushing and Mixing in
Marinas." (See complete entry in Sec-
tion VI.)

Nihoul, J. C. J., ed. Marine Forecasting;
Predictability and Modelling in Ocean
Hydrodynamics; Proceedings, 10th Interna-
tional Liège Colloquium on Ocean Hydrody-
namics. (See complete entry in Sec-
tion I.)

Noble, M., Butman, B., and Williams, E. "On
the Longshelf Structure and Dynamics of
Subtidal Currents on the Eastern United
States Continental Shelf." (See complete
entry in Section I.)

Novak, P., and Cábelka, J. Models in Hy-
draulic Engineering, Physical Principles
and Design Applications. (See complete
entry in Section VI.)

O'Connor, D. J., and Lung, W. "Suspended
Solids Analysis of Estuarine Systems."
(See complete entry in Section VI.)

O'Connor, D. J., Mueller, J. A., and Farley,
K. J. "Distribution of Kepone in the
James River Estuary." (See complete entry
in Section IV.)

Onishi, S., and Nishimura, T. 1980. "Study
on Vortex Current in Strait with Remote-
Sensing," Proceedings, Seventeenth Coastal
Engineering Conference, March 23-28, 1980,
Sydney, Australia, ASCE, III:2655-2670.

With rapid increases of industrial activ-
ity in the present, water pollution in the
coastal environment has become an urgent
problem to cope with. This problem is
especially serious in enclosed bays or
inland seas. The hydrodynamic character
of the strait connecting the inland sea to
the open ocean must be understood well in
order to analyze the diffusion of pollut-
ants in the inland sea, because its char-
acter determines boundary conditions in
the mathematical models of the water pol-
lution problem. So far, however, it seems
that the main efforts exerted by coastal
engineers have concentrated mainly on the
development of mathematical models, lack-
ing satisfactory knowledge of the boundary
conditions through field measurements.
One reason for this state results from the
fact that the relating phenomena in the
field are of too large a scale, in gen-
eral, to perform the field measurements.
In connection with this point, the authors
present in this paper that remote-sensing
technology is very useful to get informa-
tion on the hydrodynamical phenomena
occurring in the water body around the
strait. To show the above, the authors
selected as an object of the study Naruto
Strait in the Seto Inland Sea, which is
world famous for the existence of rapid

tidal currents and dynamic vortices.
Remote-sensing data both from the air-
planes and from a space satellite Landsat
are analyzed with the aid of theoretical
considerations and hydraulic model tests
to disclose the behavior of the vortices
of various scales and their roles in the
seawater mixing phenomena at the strait.
References (2 items).

Outlaw, D. G. "Lake Pontchartrain and
Vicinity Hurricane Protection Plan; Re-
port 1, Prototype Data Acquisition and
Analysis." (See complete entry in Sec-
tion I.)

Owen, M. W., and Thorn, M. F. C. "Effect of
Waves on Sand Transport by Currents."
(See complete entry in Section II.)

Ozturk, Y. F. "Mathematical Modeling of
Dispersion in Mixed Estuaries." (See com-
plete entry in Section VI.)

Pape, E. H., III, and Garvine, R. W. "The
Subtidal Circulation in Delaware Bay and
Adjacent Shelf Waters." (See complete
entry in Section VI.)

Pearson, C. "Far-Field Matching for Tidal
Calculations in Nearshore Regions." (See
complete entry in Section I.)

Pethick, J. S. "Long-Term Accretion Rates
on Tidal Salt Marshes." (See complete
entry in Section II.)

Pethick, J. S. "Velocity Surges and Asym-
metry in Tidal Channels." (See complete
entry in Section VI.)

Pickett, E. B., and Greer, H. C. 1977.
"Los Angeles Harbor and Long Beach Harbor:
Prototype Data Acquisition and Observa-
tions," Ports '77, 4th Annual Symposium of
the Waterway, Port, Coastal and Ocean Di-
vision of ASCE, Long Beach, Calif., March
9-11, 1977, I:10-26.

Wave data were obtained at 1-sec intervals
from 1 June 1971 to 1 July 1972 at 13 wave
gage stations in the Los Angeles and Long
Beach Harbors. Tidal height data were
obtained from three float-type tide gages
operated by the Los Angeles and Long Beach
Port Authorities. Barometric pressure was
monitored at the central receiving station
onshore. For 15 stations in the harbors,
tidal current measurements at three depths
in the water column were collected at 1-hr
intervals for a 25-hr observation period
beginning at 0600 PDT on 5 March 1974.
Data on ship characteristics, mooring con-
figurations, and ship motion (degree,
type, and time of occurrence) were col-
lected for vessels berthed in the east
channel and west basin of Los Angeles Har-
bor and in the southeast basin and east
basin (slip 1) of Long Beach Harbor. The

purpose of this prototype wave observation program was to obtain for a 1-yr period continuous, accurate, and reliable wave data to be used in hydraulic and mathematical models and in evaluating surge conditions in the existing harbors. Tidal heights and currents were measured to provide data for physical hydraulic model verification and to aid in identifying potential circulation problems. Ship movement and mooring configuration data were collected to allow correlation of ship motions with prototype wave conditions. References (3 items).

Prandle, D. 1980. "Co-Tidal Charts for the Southern North Sea," Deutsche Hydrographische Zeitschrift, 33(4):68-81.

Co-tidal charts have been constructed for the region of the North Sea south of 53°30' N for the constituents O_1, K_1, N_2, M_2, S_2, M_4, MS_4, and M_6. The charts are based on elevation data from about 50 coastal sites and 25 offshore sites together with current data from 17 locations. The current data and most of the offshore tide gage data were collected during the international oceanographic exercise JONSDAP '73 carried out in September and October of 1973. In constructing the charts reference was made to the pattern of tidal propagation produced by a numerical model of the area. References (7 items).

Prandle, D., and Wolf, J. "The Interaction of Surge and Tide in the North Sea and River Thames." (See complete entry in Section VI.)

Price, W. A., Motyka, J. M., and Jaffrey, L. J. "The Effect of Offshore Dredging on Coastlines." (See complete entry in Section V.)

Proehl, J. A., and Rattray, M., Jr. "Low-Frequency Response of Wide Deep Estuaries to Non-Local Atmospheric Forcing." (See complete entry in Section VI.)

Provis, D. G., and Lennon, G. W. "Eddy Viscosity and Tidal Cycles in a Shallow Sea." (See complete entry in Section VI.)

Pruszak, Z., and Zeidler, R. B. "Sediment Transport and Ripples Due to Waves and Currents." (See complete entry in Section II.)

Pugh, D. T., and Vassie, J. M. "Extreme Sea Levels from Tide and Surge Probability." (See complete entry in Section I.)

Raney, D. C. "Los Angeles Harbor and Long Beach Harbor: A Numerical Model for Tidal Circulation." (See complete entry in Section VI.)

Richards, D. R., and Gulbrandsen, L. F. "Low Freshwater Inflow Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)

Richards, D. R., and Morton, M. R. "Norfolk Harbor and Channels Deepening Study; Report 1, Physical Model Results; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)

Riedel, H. P., and Gourlay, M. R. "Inlets/Estuaries Discharging into Sheltered Waters." (See complete entry in Section I.)

Rives, S. R., and Pritchard, D. W. "Adaptation of J. R. Hunter's One-Dimensional Model to the Chesapeake and Delaware Canal System." (See complete entry in Section VI.)

Robinson, I. S., Warren, L., and Longbottom, J. F. "Sea-Level Fluctuation in the Fleet, an English Tidal Lagoon." (See complete entry in Section VI.)

Schwarze, H., and Falldorf, W. "Influence on Temperature Increases in Tidal Rivers Caused by Waste Heat Injections with Respect to Tidal Cycles and Storm Surges." (See complete entry in Section VI.)

Schwing, F. B., and Kjerfve, B. 1980. "Longitudinal Characterization of a Tidal Marsh Creek Separating Two Hydrographically Distinct Estuaries," Estuaries, 3(4):236-241.

Jones Creek, South Carolina, connects two hydrographically distinct estuarine systems: North Inlet and Winyah Bay. One hundred fifty-two sets of hydrographic measurements from February 1978 indicate the existence of a Jones Creek nodal point, an effective barrier limiting flow exchange between the end regions of the creek. Morphologic and vegetation observations and water quality ratings suggest that this nodal point is a permanent feature of Jones Creek and may be present in other similar systems. References (18 items).

Seabergh, W. C. "Model Testing of Structures at a Tidal Inlet." (See complete entry in Section VI.)

Seabergh, W. C., and Outlaw, D. G. "Los Angeles and Long Beach Harbors Model Study; Numerical Analysis of Tidal Circulation for the 2020 Master Plan." (See complete entry in Section VI.)

Seibert, G. H. "Tidally Forced Circulation in the Saguenay Fjord." (See complete entry in Section I.)

Sengupta, S., Lee, S. S., and Miller, H. P.
"Three-Dimensional Numerical Investigat-
ions of Tide and Wind-Induced Transport
Processes in Biscayne Bay." (See complete
entry in Section VI.)

Sharp, J. J. Hydraulic Modelling. (See
complete entry in Section VI.)

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   Tide tables for French coasts published by
   the Service Hydrographique et Océanograph-
   ique de la Marine are based upon tidal
   prediction at Brest from which the pre-
   dictions for the other ports are deduced
   by applying time and height differences.
   This article explains and estimates the
   formula called Formule de Laplace used to
   predict the tide at Brest. Two other
   methods, opposed to it, are found more
   efficient. However the traditional for-
   mula has been maintained owing to the
   repercussion--not yet evaluated--of the
   change of method on the tide tables qual-
   ity. The concept Brest-référence, a
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ence, 10(4):383-391.

   Time series of bottom pressure and surface
   water level are used to compute harmonic
   constants and thus compare tidal condi-
   tions at and near an inlet along Florida's
   Atlantic coast. Supportive hydrographic
   and surface atmospheric pressure data are
   incorporated to estimate the probable max-
   imum errors in comparing pressure fluctua-
   tions with water level variations. The M_2

   tidal amplitude decreases from 0.45 deci-
   bar (0.45 m ± 0.02 m) over the inner shelf
   to 0.28 m in the nearby inlet. There is
   an 11-deg phase lag of the M_2 tide in the
   inlet. The K_1 and O_1 constituent ampli-
   tudes show essentially no decrease from
   the shelf to the inlet, though the tidal
   wave form is delayed by 9 deg and 18 deg,
   respectively. Locally damped amplitudes
   and phase lags are attributed to
   estuarine-shelf exchanges through the
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Estuarine water movements occur over a broad range of time scales. In this study, moored current meter data were used to investigate water volume exchange in the tidal passes of Lake Pontchartrain, Louisiana, on the tidal and subtidal time scales. A calibration technique, employing cross-channel measurements of water velocity, was used to calibrate the moored current meters, thus allowing for calculation of volume flow over a 35-day period. The local diurnal tide accounted for 50 percent of the total volume exchange, the rest being due to subtidal events (frontal passage). This subtidal exchange occurs primarily as large-scale events characterized by volume fluxes up to six times greater than the normal tidal prism. Neglecting this subtidal component in the determination of the volume fluxes for a system such as Lake Pontchartrain could result in substantial underestimation (by as much as 50 percent) of these volume and their corresponding material fluxes. References (15 items).

Swift, M. R., and Brown, W. S. 1983. "Distribution of Bottom Stress and Tidal Energy Dissipation in a Well-Mixed Estuary," Estuarine, Coastal and Shelf Science, 17(3):297-317.

Estimates of area-averaged tidal bottom stress are made for four channel segments of the Great Bay Estuary, N. H. Current and sea level measurements are used to estimate acceleration and pressure gradient terms in the equation of motion, while the equation of motion itself is used to infer the remaining stress term. Dynamic terms, bottom stress values, friction coefficients, and energy dissipation rates are estimated for each site. The analysis shows that while throughout the estuary the principal force balance is between the frictional stress and the pressure gradient forcing, RMS values of total bottom stress range from 2.67 to 10.38 Nm^{-2} and friction coefficients vary from 0.015 to 0.054. Both stress and energy dissipation are largest in the seaward portion of the estuary with an order of magnitude decrease in dissipation at the most inland site. These distributions of stress and energy dissipation are consistent with cotidal charts of the principal semidiurnal tidal constituent (M_2) which indicate that the estuary is composed of a highly dissipative more progressive tidal wave regime seaward and a less dissipative standing wave regime landward. References (19 items).

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Current meter measurements indicate the presence of a mean Ekman spiral imposed upon the dominant tidal oscillation of the St. Lawrence Estuary. Estimates of vertical eddy coefficients are consistent with previous estimates. It is hypothesized that the spiral results from a steady, fresh, river outflow layer flowing over the tidal prism. References (5 items).

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Uncles, R. J., et al. "Salinity of Surface Water in a Partially-Mixed Estuary, and Its Dispersion at Low Run-off." (See complete entry in Section III.)

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Wadsworth, J. R., Jr. "Structural Control of Drainage Morphology of Salt Marshes on St. Catherine's Island, Georgia." (See complete entry in Section I.)

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In order to examine physical processes in the subtidal time range, sea level and current meter data for south San Francisco Bay (South Bay) were filtered using a low-pass digital filter to remove tidal period variations, and then subjected to an empirical orthogonal function analysis. For the sea level data, there is one dominant empirical mode that is correlated with nonlocal coastal forcing. A small amount of the variance is associated with local wind setup. For the current meter data, there are two dominant empirical modes that correlate with local wind forcing and tidal forcing over the spring-neap cycle. In general, South Bay is dominated by coastal forcing on sea level during all seasons, and dominated by wind and tidal forcing on the residual currents during the summer. References (17 items).

Walters, R. A., and Heston, C. 1982. "Removing Tidal-Period Variations from Time-Series Data Using Low-Pass Digital Filters," Journal of Physical Oceanography, 12(1):112-115.

Several low-pass digital filters are examined for their ability to remove tidal period variations from a time series of water surface elevation for San Francisco Bay. The most efficient filter is the one which is applied to the Fourier coefficients of the transformed data, and the filtered data recovered through an inverse transform. The ability of the filters to remove the tidal components increased in the following order: (a) cosine-Lanczos filter; (b) cosine-Lanczos squared filter; (c) Godin filter; and (d) a transform filter. The Godin filter is not sufficiently sharp to prevent severe attenuation of 2- to 3-day variations in surface elevation resulting from weather events. References (4 items).

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Landsat (formerly called ERTS-1) data recorded on computer-compatible tapes (CCT's) augmented by data derived from ground control measurements were used to determine the feasibility of detecting alterations of the optical properties of water caused by the movement of suspended particles and solutes in selected portions of the Chesapeake Bay area. Techniques were developed to process CCT's on a PDP-15 computer, establish correlations of radiance and suspended material concentrations, and produce suspended material distribution photomaps. This report discusses these techniques, and includes in appendixes a discussion of experience with automated data collection systems in connection with this study, validation of the computer algorithms for high suspended material concentrations, and by-products that resulted from this study. References (16 items).

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REPORTS OF COMMITTEE ON TIDAL HYDRAULICS

Report No.	Title	Date
1	Evaluation of Present State of Knowledge of Factors Affecting Tidal Hydraulics and Related Phenomena	Feb 1950
2	Bibliography on Tidal Hydraulics	Feb 1954
	Supplement No. 1, Material Compiled Through May 1955	Jun 1955
	Supplement No. 2, Material Compiled from May 1955 to May 1957	May 1957
	Supplement No. 3, Material Compiled from May 1957 to May 1959	May 1959
	Supplement No. 4, Material Compiled from May 1959 to May 1965	May 1965
	Supplement No. 5, Material Compiled from May 1965 to May 1968	Aug 1968
	Supplement No. 6, Material Compiled from May 1968 to May 1971	Jul 1971
	Supplement No. 7, Material Compiled from May 1971 to May 1974	Jun 1975
	Supplement No. 8, Material Compiled from June 1974 to June 1980	Dec 1980
	Supplement No. 9, Material Compiled from June 1980 to June 1983	Jun 1985
3	Evaluation of Present State of Knowledge of Factors Affecting Tidal Hydraulics and Related Phenomena (revised edition of Report No. 1)	May 1965

Technical Bulletin No.	Title	Date
1	Sediment Discharge Measurements in Tidal Waterways	May 1954
2	Fresh Water-Salt Water Density Currents, a Major Cause of Siltation in Estuaries	Apr 1957
3	Tidal Flow in Entrances	Jan 1960
4	Soil as a Factor in Shoaling Processes, a Literature Review	Jun 1960
5	One-Dimensional Analysis of Salinity Intrusion in Estuaries	Jun 1961
6	Typical Major Tidal Hydraulic Problems in United States and Research Sponsored by the Corps of Engineers Committee on Tidal Hydraulics	Jun 1963
7	A Study of Rheologic Properties of Estuarial Sediments	Sep 1963
8	Channel Depth as a Factor in Estuarine Sedimentation	Mar 1965
9	A Comparison of an Estuary Tide Calculation by Hydraulic Model and Computer	Jun 1965
10	Significance of Clay Minerals in Shoaling Problems	Sep 1966
11	Extracts from the Manual of Tides	Sep 1966
12	Unpublished Consultation Reports on Corps of Engineers Tidal Projects	Dec 1966
13	Two-Dimensional Aspects of Salinity Intrusion in Estuaries. Analysis of Salinity and Velocity Distributions	Jun 1967
14	Tidal Flow in Entrances. Water-Level Fluctuations of Basins in Communication with Seas	Jul 1967
15	Special Analytic Study of Methods for Estuarine Water Resources Planning	Mar 1969
16	The Computation of Tides and Currents in Estuaries and Canal	Sep 1969
	Appendix A A User's Manual	Jun 1973
17	Estuarine Navigation Projects	Jan 1971
18	History of the Corps of Engineers Committee on Tidal Hydraulics	Jun 1972
19	A Field Study of Flocculation as a Factor in Estuarial Shoaling Processes	Jun 1972
20	Unsteady Salinity Intrusion in Estuarines	
	Part I One-Dimensional Transient Salinity Intrusion with Varying Freshwater Inflow	Jul 1974
	Part II Two Dimensional Analysis of Time-Averaged Salinity and Velocity Profiles	Jul 1974
21	Evaluation of Numerical Storm Surge Models	Dec 1980

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